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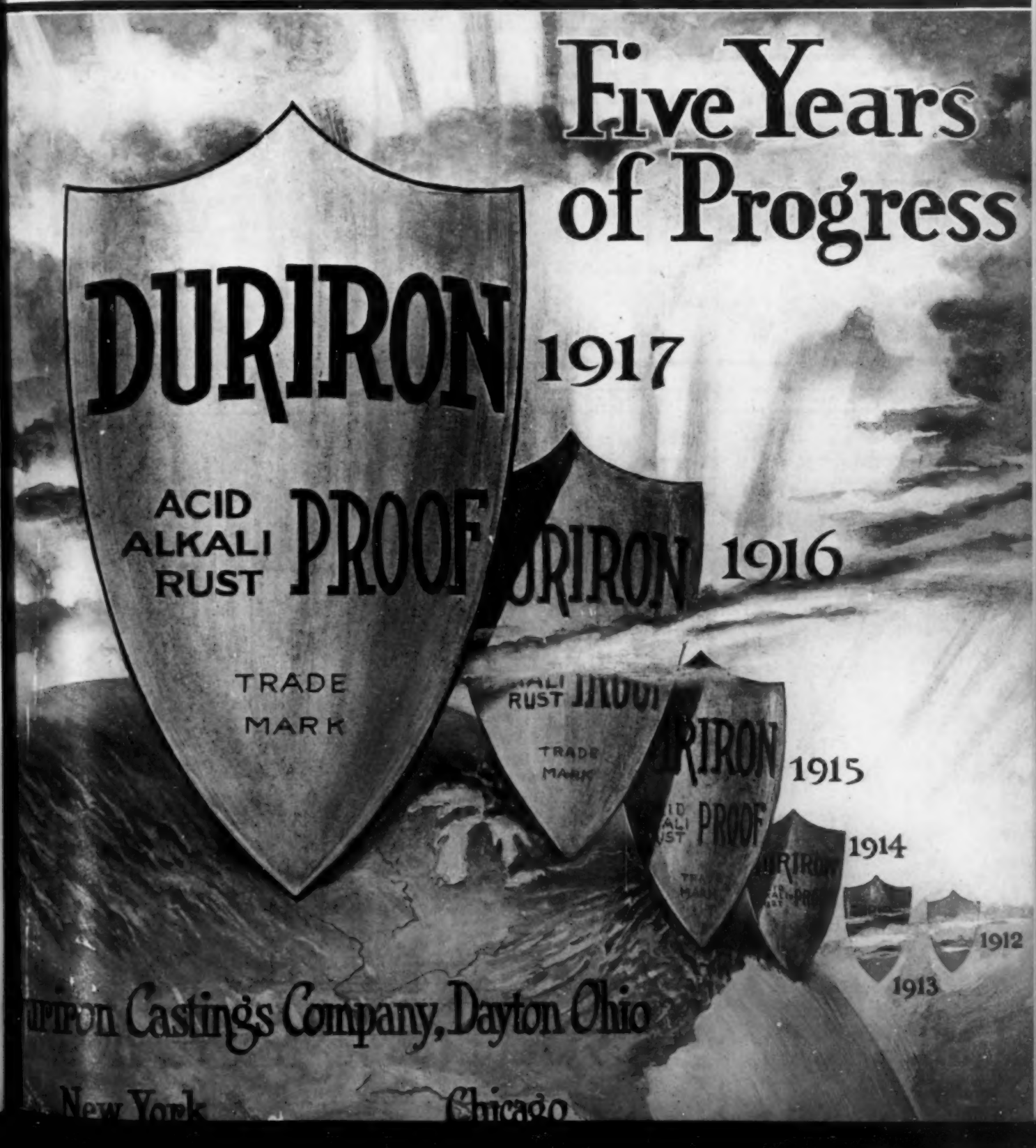

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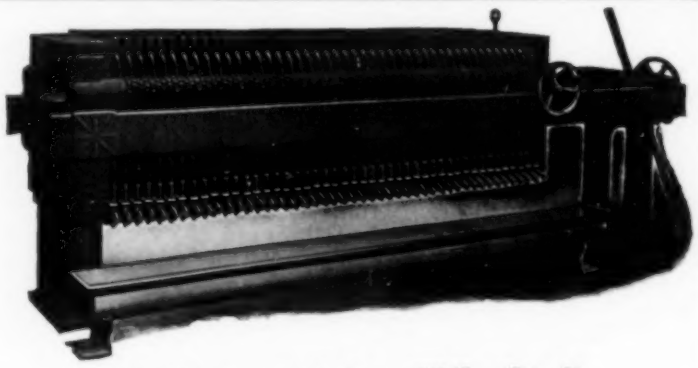

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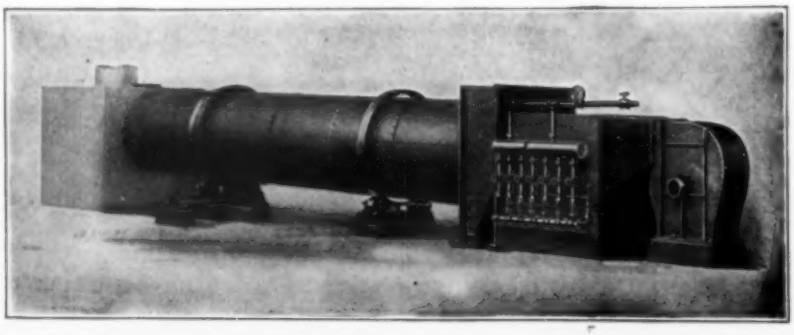

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The Chemical Exposition

American chemical industry at high pressure is the impression gained by the visitor to the Third National Exposition of Chemical Industries. Excelling in magnitude and importance its two predecessors, the Exposition fitly typifies the wonderful growth and progress in industrial chemistry during the past year. Combining the exhibits with moving pictures of metallurgical and chemical industry and the technical sessions of chemical societies, the Exposition afforded educational possibilities unsurpassed in so small a time and area.

A number of features strike even the casual visitor and are worthy of brief note. First, the exhibits from the South made a deep impression regarding the present development and future possibilities of industrial chemistry in that part of our country. With raw materials, labor and power at hand in contiguous districts, the optimist of the South may be pardoned if he counts his region the greatest undeveloped asset of our country, and considers the present development to be trifling in comparison with future promise. Many of the southern exhibits were made by railroads and cities, indicating the strong forces that are behind this future development.

Another outstanding feature was the exhibition made by the related elements of the dyestuff industry. One was impressed with the great increase in by-product coking and the utilization of by-products for dye-making. Coal as a chemical microcosm was never displayed to better advantage than in the variety of exhibits shown at the Exposition.

From a metallurgical point of view the exhibits demonstrated remarkable progress in the manufacture of alloys for chemical purposes. The ability of the metallurgist to meet industrial demands, in the quality and quantity of alloys produced, as well as in the size of castings, is apparently without reasonable limit. The great quantity of commercial-size units of apparatus shown on the floor gave substantial evidence of what is being done. We look forward with pleasure to the fourth Exposition next year.

American Business Mobilized

Looking not only at problems pressing for immediate solution at Washington but also to the future relations of business and the Government, capital and labor, international business relations and such problems as government ownership of public utilities and the future of foreign trade, the recent War Convention of the Chamber of Commerce of the United States at Atlantic City was an important event. One gains the impression that the American business man of large affairs is viewing the future with a liberal attitude and breadth of

vision that considers the progress of human society rather than narrow selfish interest.

The old order changes rapidly, and the demand of the hour as well as of the future is an abandonment of narrow partisanship on the part of conflicting and competing interests. Changed times and conditions demand changed policies; patriotism as well as common sense call for harmonious action; race welfare is recognized as the paramount consideration of the hour. To bend business energies along these lines and subordinate many of the issues that formerly occupied attention, is the task which American business has set for itself.

The winning of the war is the first consideration and business realizes that this is more essential than making money. This is no time for capital to profiteer nor for labor to demand the closed shop; and if, out of a frank consideration of the war-time responsibilities of both parties we can emerge with clearer and broader vision and find common meeting ground, the war will have worked a change worth while.

Looking to the future of foreign trade and international relations of the United States, the convention emphasized the future necessity of shipping manufactured products instead of raw materials. This has been impressed on the metallurgical and chemical industries as a result of the war, and should receive thoughtful consideration for the future. With regard to minor as well as major, and rare as well as common, metals and products, the necessity of manufacture has become apparent. In this respect metallurgical and chemical ability is in advance of manufacture. We have the brains and ability awaiting financial and business arrangements. To-day metallurgy and chemistry are forward-looking industries, manned by able and competent men, and needing only financial co-operation and business organization for their firm establishment. With this co-operation we shall be able to meet the demand of business for industrial independence.

Scientists and Engineers in the National Defence

During the Washington meeting of the Electrochemical Society in the spring of 1916 the writer asked a friend to accept with him the invitation of the director of the Geophysical Laboratory to inspect their building and equipment. His friend declined saying something like "Why should I go over there? They have nothing but a lot of highbrows trying to find out how hot it is in the center of the earth." Meeting this body of real scientists and imbibing their enthusiasm for their work, however, was undoubtedly the most inspiring privilege of the occasion.

It is to be hoped that the ultra-practical man who didn't care how hot it was half way through the world could have attended the Boston meeting of the American Chemical Society and heard Dr. Day recount how this same group of men with their precise equipment and extraordinary learning were able to formulate and produce in the United States optical glass equal to any used in Europe, and in the amazingly short period of five months. Could he appreciate the immense value of this achievement, he would humbly thank Heaven for those same men who are giving their lives to the study of silicate minerals, ternary equilibria, and such other cryptic things.

The army officials of England and France felt much as my hard-headed friend toward the mobilization of the engineers into the trenches. Why should a chemist be kept rattling his smelly test tubes, or an engineer squinting through his transit when two-legged riflemen were needed in Flanders? Why, indeed? The answer was not altogether clear until sickening loss of human life had resulted from gas attack and from lack of powder and big guns. Then, when it was nearly too late, the engineer was put into his real job; the chemist started that flow of powder and gas which bids fair to overwhelm the enemy, the metallurgist produced that unending trail of guns and shells, big and little, while the humble surveyor mounted his "solar" on the top of a howitzer, peeked at a friendly sun or star, and sent the shells along their true courses.

While America is profiting by the experience of our Allies in many ways, the authorities seem to be blind to the special value of technically trained men. The President has indeed issued regulations regarding the exemption of medical students and hospital internes, and it is not entirely apparent why such additional provision should not be made for other technicians. Judging from the results of the activities of the National Engineering Societies, those in charge have not yet awakened to the urgency for action.

How they can continue in this attitude is a puzzle; consider for instance the list of exports forbidden to the enemy. These may be classed in the following general divisions: arms and ammunitions; transportation; bullion and money; chemicals; machinery; scientific and sanitary equipment; metals and ores; paper; rubber; fuel; foodstuffs; beverages; wood; clothing and fibers; earths; hides; organic products. The chemists or metallurgists are indispensable in no less than nine of the seventeen divisions either as king pins or foundation stones. Or examine the list of regulated exports to neutral countries and to the allies of the United States given on another page. Without the chemist or metallurgist no less than 121 out of the 206 items would be non-existent. Again, the most recent English list of absolute contraband contains 232 chemical or metallurgical products in a total of 339.

Surely if these materials are to be rigidly conserved as essential to the conduct of the war, is it not as necessary to place similar export limitations upon the brains which cunningly fashion them?

Assimilating Alien Labor

One of the most effective and important bits of work done by the Y. M. C. A. in mining camps and among aliens generally is instruction in speaking, reading and writing English. A knowledge of English on the part of foreign-born labor may be regarded as fundamental to the later acquisition of those ideas and ideals, cus-

toms and habits that we wish to inculcate in order to make a democratic American citizen. Speaking officially in his annual report for 1916, the president of the American Smelting & Refining Company says: "In the very serious and important matter of disseminating American ideals more thoroughly in the minds of our foreign-born labor, we are trying various methods of inducing the men to learn to read and speak English." This sentiment will probably find approval among high and subordinate officials of other companies, large or small, that have to deal largely with alien labor.

A common medium of expression seems essential to the mutual welfare of men who are are associated industrially, but who normally speak different tongues. It becomes a common point of contact and encourages closer relations. As an ideal means to this end we have had the suggestion of a universal language, and a number of engineers have from time to time interested themselves in Esperanto. Lacking the immediate attainment of such an ideal, however, the next best step is to familiarize the foreigner with the language of his adopted country. This is not merely to enable him to understand orders and perform his work intelligently, though that is essential; but there is the need of broadening his understanding and inculcating our ideals of government and citizenship. At the same time it is desirable that he be able to express his own ideas, hopes, aims and ambitions in terms intelligible to us. The lack of a common medium of expression is often the cause of misunderstandings of a minor nature which later may have grave consequences. Matters in dispute are not readily explained, and trouble is easily fomented by unscrupulous agitators speaking in a foreign tongue.

The problem in Colorado is being approached in a way that promises much for the future of industry in that State. The idea was suggested by Paul Lee Ellerbe, chief examiner of the U. S. Naturalization Bureau, Denver, as a result of the difficulties encountered by him in properly preparing aliens for naturalization. The aid of the extension department of the State University was enlisted, and classes have been organized in the industrial and mining centers of the State where foreigners are given instruction in English and citizenship. These classes are under the general direction of the extension division of the University, and are visited periodically by a field representative. The instruction is given by competent and interested citizens of the several localities, who devote several evenings a week to the work and find a wholesome response to their efforts. The idea is susceptible of elaboration and extension to include elementary instruction in other subjects. State Universities and Schools of Mines are the logical mediums for the work, while mining and industrial companies can and do co-operate by affording a place for meeting or contributing to the expense of instruction. The work is elementary, but fundamental in its importance as a factor in the assimilation of foreign-born labor into our body politic.

Silver and Gold

The price of silver has had a rapid rise of late, passing the dollar mark on Sept. 14, when the New York quotation was $1.005 per ounce. This fulfills the prediction of "dollar silver" made shortly after the beginning of the war, when it became apparent that the demand for gold would exceed the available supply and that silver would be needed as additional currency. To silver-producing districts such as Cobalt and Tonopah, this increase in price will come as a welcome offset to the extraordinary costs of mining and milling which have mounted rapidly in the past year. The change has not come as quickly as some predicted and hoped, but it has arrived inevitably in accordance with economic laws.

A shortage in the production of silver and the hoarding of a diminishing supply of gold are the fundamental reasons for the enhanced price of the former. Prior to 1893, when the Indian mints were closed to the coinage of rupees on private account, the import of silver into India was four times that of gold. India became known as the "sink hole" of silver, for once the metal was imported it never came out again. This condition then gradually changed as imports of gold into India increased as those of silver fell off. Absorption and hoarding proceeded until India became a "sink hole" of gold instead of silver. Hoarding also has occurred in other countries in recent years.

The enhanced value of silver has created an anomalous condition in the coinage of several governments, because the bullion value of silver coins has exceeded their value as circulating media of exchange. Thus the bullion value of the Honduras peso is now about 75 cents, whereas its gold value has long been quoted as 44 cents. The government is reported as meeting the situation by reminting the 250,000 pesos now in circulation into new coins of half the former silver content, thus creating 500,000 pesos of new currency. The new coins are to be accepted by the government in payment of custom duties and other obligations. Similar difficulties are encountered in Mexico, that peso being now worth about 75 cents gold. The Philippine peso also is above par, and regulations are in effect preventing its exportation as bullion. In the United States we are not yet confronted with a similar condition, for silver will have to sell at $1.29 per ounce before the price will equal our coinage value or parity with gold at a ratio of 16 to 1.

The general situation is well reflected in mining and metallurgical activity. Gold producers are confronted with the problem of meeting increased costs without being able to realize more for their product; and manufacturers of mining and milling machinery report a dearth of inquiries from new or prospective gold producers. Silver mines, on the other hand, are enjoying an approach to prosperity, with an increased price for their product with which to meet abnormally high costs of operation. In due time we may look for greater activity in silver mining if the price for the metal holds close to the dollar mark.

The Western Metallurgical Field

Settlement of Montana Copper Strikes

Sept. 17 was the date fixed for resumption of work in Montana following the labor strikes which affected the Anaconda Copper Mining Co. at its mines in Butte and reduction works at Anaconda and Great Falls. Based on a monthly production of about 29,000,000 lb. of copper it is estimated that the strike has delayed production to about 75,000,000 lb.

The strike was initiated through trouble occurring about two months ago between the electrical workers and the Montana Power Co., the men asking for $6 instead of $5 per 8-hour day, and for five and one-half days per week.

The power company was reluctant to grant all demands, and the men succeeded through union organization in arousing the mechanics of the Anaconda Copper Mining Co. to make certain demands on Mr. John Gillie, general manager. The exact wording was as follows:

"Unless the mining companies will bring pressure to bear to have the Montana Power Company grant their demands; and the mining companies grant the demands recently made by the miners, the members of No. 65 employed by the companies will be pulled off."

Mr. Gillie refused the demand and the electrical workers walked out.

On June 12 a general strike was called among the miners in Butte, which was not very effective until picketing was started. Both men and women among the Finns and Austrians participated in the picketing with the result that only about 50 per cent of the men reported for work. About this time the Anaconda company offered a new scale of wages, presented herewith, and work was resumed at the mines. An attempt was made to put a quietus on the I. W. W. element by men who took affairs into their own hands and lynched one of the disturbing leaders. Later, however, the I. W. W., encouraged by foolish remarks made by Miss Jeanette Rankin, Congresswoman from Montana, went to Anaconda and succeeded in persuading the smeltermen to quit work. The smelter was accordingly closed on Aug. 24, and the mines were again forced to close. The walk-outs on the part of individual unions were in spite of the fact that the Metal Trades Council, comprising twenty-one unions, had previously passed upon and accepted the wage-scale offered by the company.

Mr. W. H. Rogers, federal mediator, made an investigation of conditions and on Sept. 11 a general meeting was held at Anaconda at which the unions voted to reconsider the new wage scale. The result was the acceptance of the company's proposal and a general signing of cards requesting resumption of work. About 30 per cent of the normal crew reported for the day shift on Sept. 17, and it is expected that conditions will steadily improve.

Activity in the Missouri-Kansas-Oklahoma District

Visitors to the St. Louis meeting of the American Institute of Mining Engineers are to be treated to a trip through the wonderful zinc-lead districts of Missouri, Kansas and Oklahoma. Local committees are now busy preparing a souvenir book on the district, which is sure to reveal a condition not fully appreciated. As a forerunner to this, we note that the statistician of the Joplin *News-Herald* has compiled the total value of the metal output of the district since records first were kept. From 1859 to the present, including the first seven months of 1917, he estimates a total production value of lead and zinc amounting to $354,658,243. Extraordinary conditions this year account for $26,204,685 of the total.

Among the new mills and smelters planned in the district are a 600-ton mill for the U. S. Smelting Co., and one of 800 tons capacity for the Brown & Head Zinc Co. Both are announced as the most modern concentrators in the district, using ball mills for regrinding, and flotation for fine concentration in addition to the customary rougher and cleaner jigs and

ANACONDA COPPER MINING CO.
COMPARATIVE WAGE RATE OF PRINCIPAL OCCUPATIONS AT THE MINES AND REDUCTIONS WORKS,—BUTTE, ANACONDA AND GREAT FALLS

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	Und. 15c	15c and Und. 17c	17c and Und. 19c	19c and Und. 21c	21c and Und. 23c	23c and Und. 25c	25c and Und. 27c	27c and Und. 29c	29c and Und. 31c
Old scale miners, all underground men engaged in mining	$3.50	$3.75	$4.00	$4.25	$4.25	$4.25	$4.50	$4.50	$4.75
New scale for same	**3.50**	**4.00**	**4.25**	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**
Old scale for miners in shaft, station cutting and winzes	4.00	4.25	4.50	4.75	4.75	4.75	5.00	5.00	5.25
New scale for same	**4.00**	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**	**6.25**
Old scale blacksmiths, carpenters, machinists, electricians, boilermakers, painters	4.50	4.75	4.75	5.00	5.00	5.00	5.25	5.25	5.50
New scale for same	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**	**6.25**	**6.50**
Old scale, helpers for craftsmen	3.50	3.75	3.75	4.00	4.00	4.00	4.25	4.25	4.50
New scale for same	**3.50**	**3.75**	**4.00**	**4.25**	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**
Old scale, stationary engineers	4.00	4.25	4.50	4.50	4.75	4.75	5.00	5.00	5.25
New scale for same	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**	**6.25**	**6.50**
Old scale, hoisting engineers (first motion)	4.50	4.75	5.00	5.25	5.25	5.25	5.50	5.50	5.75
New scale for same	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**	**6.25**	**6.50**	**6.75**	**7.00**
Old scale, hoisting engineers (geared)	4.00	4.25	4.50	4.50	4.75	4.75	5.00	5.00	5.25
New scale for same	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**	**6.25**	**6.50**
Old scale, boiler cleaners	3.75	4.00	4.00	4.25	4.25	4.50	4.75	4.75	5.00
New scale for same	**4.00**	**4.25**	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**
Old scale, boiler cleaners' helpers	3.00	3.25	3.25	3.50	3.50	3.75	4.00	4.00	4.25
New scale for same	**3.50**	**3.75**	**4.00**	**4.25**	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**
Old scale, diamond drill runners	4.00	4.25	4.50	4.50	4.75	4.75	5.00	5.00	5.25
New scale for same	**4.00**	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**	**6.25**
Old scale, firemen	3.50	3.75	4.00	4.00	4.25	4.25	4.50	4.50	4.75
New scale for same	**4.00**	**4.25**	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**
Old scale, laborers, special	3.50	3.50	3.50	3.50	3.75	3.75	4.00	4.00	4.25
New scale for same	**3.50**	**3.75**	**4.00**	**4.25**	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**
Old scale, laborers	3.00	3.25	3.25	3.50	3.50	3.75	4.00	4.00	4.25
New scale for same	**3.00**	**3.25**	**3.50**	**3.75**	**4.00**	**4.25**	**4.50**	**4.75**	**5.00**
Old scale, drivers, locomotive, surface	3.50	3.75	3.75	4.00	4.25	4.25	4.50	4.50	4.75
New scale for same	**3.50**	**3.75**	**4.00**	**4.25**	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**
Old scale, pumpmen	4.00	4.25	4.50	4.50	4.75	4.75	5.00	5.00	5.25
New scale for same	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**	**6.25**	**6.50**
Old scale, shift bosses	5.00	5.25	5.50	5.50	5.75	5.75	6.00	6.00	6.25
New scale for same	**5.00**	**5.50**	**5.75**	**6.00**	**6.25**	**6.50**	**6.75**	**7.00**	**7.25**
Old scale, station tenders	4.00	4.25	4.50	4.50	4.75	4.75	5.00	5.00	5.25
New scale for same	**4.00**	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**	**6.25**
Old scale, teamsters and stablemen	3.25	3.50	3.50	3.50	3.75	3.75	4.00	4.00	4.25
New scale for same	**3.25**	**3.50**	**3.75**	**4.00**	**4.25**	**4.50**	**4.75**	**5.00**	**5.25**
Old scale, tool sharpeners	4.00	4.25	4.25	4.25	4.50	4.50	4.75	4.75	5.00
New scale for same	**4.50**	**4.75**	**5.00**	**5.25**	**5.50**	**5.75**	**6.00**	**6.25**	**6.50**

(The foregoing schedule does not stop at 31 cents, but continues as per the foregoing increase at the rate of 25 cents for each 2 cents as high as the market price of copper. The column headed "25c. and Under 27c." represents the wage scale at the present time.)

tables. Announcement also is made of the construction of a new smelter, the first in the Oklahoma section of the tri-State field. This is being erected by the Ontario Smelting Co., near Quapaw, Okla., and is expected to be in operation within eight or ten weeks. It will have five furnaces with a capacity of 600 tons of ore per week. There are at present four other active lead smelters in the district: at Galena, Webb City, Joplin, and Granby.

Price Fixed for Copper

President Wilson approved on Sept. 20, an agreement between the War Industries Board and the copper producers, to furnish metal at a price of 23½ cents f.o.b., New York City. The official statement follows:

> After investigation by the Federal Trade Commission as to the cost of producing copper, the President has approved an agreement made by the War Industries Board with the copper producers, fixing a price of 23½ cents per pound, free on board, New York, subject to revision after four months. Three important conditions were imposed by the Board. First, that the producers would not reduce the wages now being paid; second, that the operators would sell to the Allies and to the public copper at the same price paid by the Government, and take the necessary measures, under the direction of the War Industries Board, for the distribution of the copper, to prevent it from falling into the hands of speculators, who would increase the price to the public, and third, that the operators pledge themselves to exert every effort necessary to keep up the production of copper to the maximum of the past, so long as the war lasts.
>
> The War Industries Board felt that the maintenance of the largest production should be assured and that a reduction in wages should be avoided. The stipulation that present wages shall not be reduced compels the maintenance of the highest wages ever paid in the industry, which without such stipulation would, with the reduction made in the price of copper, be reduced under the sliding scale so long in effect in the copper mines. Within this year copper has sold as high as 36 cents per pound, and the market price would now be higher than it is had it not been well known for some weeks that the Government would fix the price.
>
> The principal copper producers throughout the country have evinced an admirable spirit and for weeks have promptly supplied every request of the Government for copper without awaiting decision as to price and agreeing to accept the price which the board should ultimately fix. The proper departments of the Government will be asked to take over the mines and plants of any producers who fail to conform to the arrangement and price, if any such there should be.

Steel Corporation Increases Wages

The United States Steel Corporation announced that the wages of its employees would be increased 10 per cent on Oct. 1. Approximately 275,000 men will be affected by this, the second wage advance of the year, and the fifth since Feb. 1 of last year, each being 10 per cent. The successive increases will make the daily or monthly pay of the employees 60 per cent higher than it was at the end of 1915.

It is estimated that the various subsidiary companies employ about 200,000 day laborers who are now getting an average of $3 a day for ten hours' work. The increase on Oct. 1 will amount to 30 cents a day for this class of employees and will cause an aggregate increase of the corporation's annual pay-roll of approximately $18,000,000.

The Steel Corporation let it be known on the occasion of the wage increases last year that the rising cost of living and the desire of the employers to let the workers share in the abnormal profits of the period were the moving factors. Voluntary expansion of the payroll has had influence in keeping the men satisfied, as the corporation has had no serious labor difficulties since the war began.

Company Reports

In the accompanying table we present comparative figures on important items taken from the 1916 annual reports of several large copper companies, all of which are engaged in the mining and concentrating of low-grade copper sulphide ores. Other interesting facts which cannot be tabulated are given below.

Chino Copper Company's mill at Hurley, N. M., was built originally for a capacity of 5000 tons per day, but subsequent improvements in operating methods finally raised the capacity to a daily average of 8455 tons in 1916. In that year further improvements were inaugurated, and the construction of two new sections was begun. The full effect of this work probably will not be felt until the latter part of 1917. One of the sections and part of the other will supplement the original grinding equipment by an extensive installation of fine-grinding machinery and some concentrating machinery for the sulphide ores. A part of the second section will be devoted to the treatment of partly oxidized ore as long as such material is produced, after which it will be converted to the treatment of normal sulphide ore. It is estimated that the seven-section plant will have a daily capacity of 12,500 tons. An experimental plant of 100 tons daily capacity was constructed for investigation of the treatment of all classes of ore, and has afforded valuable information. A plant of 1000 tons daily capacity also has been built for the re-treatment of accumulated tailings, and when it has been run for a sufficient time to determine the best method of treatment it is the intention to increase the capacity to 5000 tons daily.

Ray Consolidated Copper Co. conducted during 1916 a campaign for greater capacity and improved metallurgical results. The effect was not apparent until the third quarter of the year, when both tonnage and extractions were the highest ever attained for a quarterly period. Further improvements are under way, and when completed will permit of better treatment of a larger tonnage than ever before. The original capacity of the mill was 6000 tons daily, but this will be raised to approximately twice that tonnage, and with better extraction than has been accomplished at any previous time.

	Utah	Chino	Ray	Inspiration	Miami	Braden
Ore reserves, tons	369,854,558	94,490,936	93,373,226	91,789,120	50,400,000[2]	219,680,000
Per cent copper	1.41	1.655	2.03	.....	.....	2.19
Ore milled, tons	10,994,000	3,094,400	3,332,340	5,316,350	1,842,017	1,362,629
Daily average, tons	30,038	8,455	9,105	14,850	5,074	3,723
Per cent copper	1.435	1.83	1.607	1.548	2.07	2.13
Concentrates, tons	.....	254,852	188,778	.....	66,289	117,984
Per cent copper	18.71	14.82	19.91	.....	42.49	.....
Copper produced, pounds	196,752,631	75,551,376	75,182,915	119,431,389	56,335,103	.....
Extraction, per cent	62.34	66.59	70.20	74.86[1]	73.88	75.07
Milling cost per ton, cents	37.82	64.00	55.35	.....	58.91	.....
Cost of copper, cents per pound	6.95	8.70	10.13	8.67	9.52	8.03

[1] Extraction of sulphide copper was 90.95 per cent; of oxide, 16.6 per cent.
[2] 16,400,000 tons at 2.4 per cent; 28,000,000 tons at 1.06 per cent; 6,000,000 tons at 2 per cent.

Inspiration Copper Co. brought the eighteenth section of its mill into operation on Feb. 21, 1916. Flotation plays a large part in the metallurgical scheme at this mill, and as a consequence the recovery on sulphide copper ore was 90.95 per cent. The recovery on oxidized ore was but 16.6 per cent. The flotation concentrate carried 37.5 per cent copper and the table concentrate 11.23 per cent. Steel ball consumption per ton of ore treated was 1.76 lb. Flotation oil consumption per ton of ore milled was 1.286 lb., of which 1.2 lb. was coal tar and the balance other oils. Two additional sections of the mill were started in 1916, making 20 in all. The completed mill will have a capacity of about 18,000 tons per day, while the mine is in condition to supply 20,000 tons daily. Active experimental work was undertaken during the year on the treatment of oxide ores, of which the company has about 20,000,000 tons in reserve. A leaching scheme is now being tried out in a small plant.

Miami Copper Co. expects ultimately to bring its concentrating plant to a daily capacity of 6000 tons through changes in the mill, as determined from the operation of a 100-ton test mill. Changes will consist mainly in the increase of grinding capacity and provision of treatment facilities to handle the increased tonnage of more finely ground ore. Intermediate crushing rolls will be replaced by Hardinge conical mills, and the present fine-grinding mills by similar machines of greater capacity operating in closed circuit. All changes are expected to be completed by the close of 1917. Encouraging results have been obtained from experiments on treatment of oxidized copper ore, and a process is being tested on a large scale.

Braden Copper Co. states in its annual report for 1916 that the mill recovery has been greatly improved by the new air cells, and that the mill capacity is now about 5000 tons daily. In view of the large ore reserves, the management has considered the ultimate enlargement of the plant to 10,000 tons daily. Owing to a failure of the tailings dam in June, a new tailings dump has been secured about eight miles by flume line from the mill. This site has capacity for 200,000,000 tons, and will permit of safer and cheaper tailings disposal. The proposed enlargement of the concentrating mill made it necessary to change the location of the proposed new smelting plant from Sewell to Caletones, seven miles distant. Concentrates will be transported from mill to smelter by aerial tramway. A new department has been organized for welfare work among the company's employees. A sum of $2,000,000 has been set aside for the organization and operation of this department, which will look after housing, sanitation, amusements, education, and safety of a population of about 10,000 people.

Steel Prices and Priority Rules

A formal announcement was issued Sept. 24, regarding the price of steel and allied products, as follows:

> The President has approved an agreement between the War Industries Board and the steel men, fixing the following prices, which become effective immediately, and are subject to revision Jan. 1, 1918:
>
> Iron ore, lower lake ports.....$5.05 per gross ton
> Connellsville coke .....$6.00 per net ton
> Pig iron .....$33.00 per gross ton
> Steel bars, Pittsburgh or Chicago .....$2.90 per hundredweight
> Shapes, Pittsburgh or Chicago.$3.00 per hundredweight
> Plates, Pittsburgh or Chicago.$3.25 per hundredweight
>
> It was stipulated, first, that there should be no reduction in the present rate of wages; second, that the prices above named should be made to the public and to the Allies, as well as to the Government, and, third, that the steel men pledge themselves to exert every effort necessary to keep up the production to the maximum of the past, so long as the war lasts.
>
> Measures will be taken by the War Industries Board for placing orders and supervising the output of the steel mills in such manner as to facilitate and expedite the requirements of the Government and its allies for war purposes, and to supply the needs of the public according to their public importance and in the best interest of all, as far as practicable.
>
> A spirit of co-operation was manifested by the steel men, and no doubt is entertained that every effort will be made to bring the production as nearly as possible up to the extraordinary demands resulting from the war.

It is understood that the prices now quoted will not affect existing contracts, at least where war work is involved, and that pending the time when these contracts run out—they are usually for about seven months in the steel industry—the average price paid for steel will be at least $75 or $80, perhaps somewhat more.

The United States Shipping Board, through its Emergency Fleet Corporation, has been paying $50 a ton on account for steel plates, pending the announcement of the Government price.

The Navy Department has been paying, under agreement with the steel industry, $58 a ton for plates. This price will be maintained for the contracts already entered into, and the navy will then join the other Governmental agencies, the Allies, and the public in paying $65 for its plates.

Coincident with the President's announcement, Judge Robert S. Lovett, chairman of the Priority Board, issued a statement placing the distribution of iron and steel under absolute control by license. Preference will be given to the War and Navy Departments and the Emergency Fleet Corporation of the United States Shipping Board. Next will come the supply for the needs of the Allies. Private interests not engaged in war work must wait until the last before obtaining supplies.

The announcement of the board's plans through the Committee on Public Information reads in part:

> Under these regulations all orders and work are divided into three classes:
>
> Class A comprises war work—that is to say, orders and work urgently necessary in carrying on the war, such as arms, ammunition, ships, etc., and the materials required in their manufacture.
>
> Class B comprises orders and work which, while not primarily designed for the prosecution of the war, yet are of public interest and essential to the national welfare, or otherwise of exceptional importance.
>
> Class C comprises all orders and work not embraced in Class A or Class B.
>
> All orders henceforth will be classed as Class C, unless covered by certificates of the Priorities Committee. No certificates will be issued for Class C orders.
>
> Orders and work in Class A will take precedence over those in Class B, and both these classes will be given priority over Class C, irrespective of the date the orders were received. Class A and Class B will, in turn, be separated into subdivisions to be designated as Class A1, A2, A3, A4, etc., and Class B1, B2, B3, B4, etc., each composed of orders within the class which are regarded respectively as of greater moment and to be given precedence in accordance with the serial number. All materials required in the manufacture of an article or in the prosecution of any work will be entitled to take the class of such article or work unless otherwise specified.

The Regulation of Exports

The Espionage Act, approved June 15, 1917, provides for the regulation of exports in order that the United States may better conserve its resources and more efficiently use its exports and exporting facilities to aid in the prosecution of the war.

PURPOSE OF LAW

The purpose of the law and what is expected to be accomplished through its enforcement are probably best explained in the statement of the President, issued June 26, 1917:

> "It is important that the country should understand just what is intended in the control of exports which is about to be undertaken, and since the power is vested by the Congress in the President, I can speak with authority concerning it. The Exports Council will be merely advisory to the President.
>
> "There will, of course, be no prohibition of exports. The normal course of trade will be interfered with as little as possible, and, so far as possible, only its abnormal course directed. The whole object will be to direct exports in such a way that they will go first and by preference where they are most needed and most immediately needed, and temporarily to withhold them, if necessary, where they can best be spared.
>
> "Our primary duty in the matter of food-stuffs and like necessities is to see to it that the people associated with us in the war get as generous a proportion as possible of our surplus; but it will also be our wish and purpose to supply the neutral nations whose peoples depend upon us for such supplies as nearly in proportion to their need as the amount to be divided permits.
>
> "There will be little check put upon the volume of exports and the prices obtained for them will not be affected by this regulation.
>
> "This policy will be carried out, not by prohibitive regulations, therefore, but by a system of licensing exports which will be as simply organized and administered as possible, so as to constitute no impediment to the normal flow of commerce. In brief, the free play of trade will not be arbitrarily interfered with; it will only be intelligently and systematically directed in the light of full information with regard to needs and market conditions throughout the world and the necessities of our people at home and our armies and the armies of our associates abroad."

By proclamation of the President, of August 27, 1917, effective August 30, 1917, restrictions are listed in two distinct classes. The first includes the shipment of practically all articles of commerce, the export of which is prohibited to the enemy and its allies, and to the neutral countries of Europe; the second class includes certain commodities, the shipment of which is prohibited to countries other than those named under the first class. This classification of exports enables this country to maintain a close supervision and control of exports, with respect to those neutrals within the sphere of hostilities.

EXPORTS TO THE ENEMY AND TO THE NEUTRAL COUNTRIES OF EUROPE

The President's proclamation gives the following list of articles, the export of which to the enemy and to the allies of enemy countries and to the neutral countries of Europe will not be permitted without export licenses:

Arms, guns, ammunition and explosives of all kinds, machines for their manufacture or repair, component parts thereof, materials or ingredients used in their manufacture, and all articles necessary or convenient for their use.

Contrivances for or means of transportation on land or in the water or air, machines used in their manufacture or repair, component parts thereof, materials or ingredients used in their manufacture and all instruments, articles and animals necessary or convenient for their use; all means of communication, tools, implements, instruments, equipment, maps, pictures, papers and other articles, machines and documents necessary or convenient for carrying on hostile operations.

Coin, bullion, currency, evidences of debt, and metal, materials, dies, plates, machinery and other articles necessary or convenient for their manufacture.

Fuel, food, foodstuffs, feed, forage and clothing, and all articles and materials used in their manufacture.

Chemicals, drugs, dyestuffs, and tanning materials.

Cotton, wool, silk, flax, hemp, jute, sisal and other fibres and manufactures thereof.

Earths, clay, glass, sand and their products.

Hides, skins and manufactures thereof.

Non-edible animal and vegetable products.

Machinery, tools and apparatus.

Medical, surgical, laboratory and sanitary supplies and equipment.

Metals, minerals, mineral oils, ores, and all derivatives and manufactures thereof.

Paper, pulp, books, and printed matter.

Rubber, gums, rosins, tars, and waxes, their products, derivatives and substitutes and all articles containing them.

Wood and wood manufactures.

Coffee, cocoa, tea, and spices.

Wines, spirits, mineral waters and beverages.

EXPORTS TO NEUTRAL COUNTRIES AND TO THE ALLIES OF THE UNITED STATES

Regulation of exports to neutral countries, other than those of Europe, and to countries associated in war with the United States, is also effected. These exports which are prohibited except by license are as follows:

- Coal
- Coke
- Fuel oils:
  - Lubricating oil
  - Hand lantern oil
  - Naptha
  - Benzine
  - Red oil
  - Kerosene and gasoline including burners
- Food grains, flour and meal therefrom:
  - Corn flour
  - Barley
  - Rice flour
  - Rice
  - Oatmeal and rolled oats
  - Fodder and feeds
  - Oil-cake and oil-cake meal
  - Malt
  - Peanuts
- Meats and fats
  - Poultry
  - Cottonseed oil
  - Corn oil
  - Copra
  - Cocoanuts, dessicated
  - Butter
- Fish, dried, canned or fresh
- Grease, inedible or edible, of animal or vegetable origin
- Linseed oil
- Lard
- Tinned milk
- Peanut oil and butter
- Rapeseed oil
- Tallow
- Tallow candles
- Stearic acid
- Sugar
- Glucose
- Syrup
- Molasses
- Pig iron
- Ferrosilicon
- Spiegeleisen
- Steel ingots
- Steel billets
- Steel sheet bars
- Steel blooms
- Steel slabs
- Iron and steel plates, including ship boiler tank and all other iron and steel plate one-eighth of an inch thick and heavier, and wider than six inches
- Iron and steel structural shapes
  - Channels
  - Beams
  - Angles
  - Tees, and Zees, all sizes
- Fabricated structural iron and steel, including beams, channels, angles, tees, zees, and plates, fabricated and shipped knocked down
- Scrap iron and scrap steel
- Ferro-manganese
- Guano
- Humus
- Hardwood ashes
- Soot
- Anhydrous ammonia
- Aeronautical machines and instruments, parts and accessories thereof
- Arms, ammunition, and explosives:
  - Nitrate of potash
  - Rosin
  - Sulphur
  - Saltpetre
  - Turpentine
  - Potash and its salts
  - Mercury and its salts
  - Glycerine
  - Carbolic acid and its derivatives
  - Phenol
  - Nitric acid and its salts
  - Ether
  - Alcohol
  - Sulphuric acid and its salts
  - Acetone
  - Cyanides
  - Benzol and its derivatives
  - Toluol and its derivatives
- Carrier and other pigeons
- Anti-aircraft:
  - Instruments
  - Apparatus
  - Accessories
- Radio and wireless:
  - Apparatus
  - Accessories
- Optical glass, instruments and reflectors
- Cotton and cotton linters
- Wool, wool rags, wool and khaki clippings and wool products
- Flax, sisal, jute, hemp and manufactures thereof
- Hides, skins and leather:
  - Leather belting
  - Sole and upper leather
  - Leather boots and shoes
  - Harness and saddles
  - Leather clothing
- Soap and soap powders
- Engines and motors operated by steam, gas and electricity, or other motive power and their accessories
- Metal and wood-working machinery
- Oil well casing
- Oil well drilling implements, machinery and accessories thereof
- Steam boilers
- Turbines
- Condensers
- Pumps and accessories thereof
- Electrical equipment:
- Crucibles
- Emery
- Emery wheels

Tool steel
High speed steel
Alloy steel
Machine tools
Steel hardening materials
Fertilizers:
  Cattle and sheep manure
Nitrate of soda
Poudrette
Potato manure
Potassium salts
Land plaster
Potash
Cyanamide
Phosphoric acid
Phosphate rock
Superphosphate
Chlorate potash
Bone meal
Bone flour
Ground bone
Dried blood
Ammonia and ammonia salts
Acid phosphate
Carborundum and artificial abrasives
Copper:
  Ingots
  Bars
  Rods
  Plates
  Sheets
  Tubes
  Wires
  Scrap
Lead and white lead
Tin, tin plate, tin cans and all articles containing tin
Nickel
Aluminum
Zinc
Plumbago
Platinum
News paper, print paper, wood pulp and cellulose
Ash, spruce, walnut, mahogany, oak and birch woods
Industrial diamonds

Should Exemption for Medical Students Apply to Engineers?

In view of the suggestion that students in engineering colleges be exempted from draft in the National Army, the following memorandum from the provost marshal general to the governors of all states, exempting medical students and hospital internes, is timely:

"The President prescribes the following supplemental regulations governing the execution of the selective-service law:

"First—Hospital internes who are graduates of well-recognized medical schools, or medical students in their fourth, third or second year in any well-recognized medical school who have not been called by a local board may enlist in the Enlisted Reserve Corps provided for by Section 55 of the National Defense Act under regulations to be issued by the surgeon general, and if they are thereafter called by a local board they may be discharged on proper claim presented on the ground that they are in the military service of the United States.

"Second—A hospital interne who is a graduate of a well-recognized medical school, or a medical student in his fourth, third or second year in any well-recognized medical school, who has been called by a local board and physically examined and accepted and by or in behalf of whom no claim for exemption or discharge is pending, and who has not been ordered to military duty, may apply to the surgeon general of the Army to be ordered to report at once to a local board for military duty, and thus be inducted into the military service of the United States, immediately thereupon to be discharged from the National Army for the purpose of enlisting in the Enlisted Reserve Corps of the Medical Department. With every such request must be inclosed a copy of the order of the local board calling him to report for physical examination (Form 103), affidavit evidence of the status of the applicant as a medical student or interne, and an engagement to enlist in the Enlisted Reserve Corps of the Medical Department.

"Upon receipt of such application with the named inclosures the surgeon general will forward the case to the adjutant general with his recommendations. Thereupon the adjutant general may issue an order to such interne or medical student to report to his local board for military duty on a specified date, in person or by mail or telegraph, as seems most desirable. This order may issue regardless of the person's order of liability for military service. From and after the date so specified, such person shall be in the military service of the United States. He shall not be sent by the local board to a mobilization camp, but shall remain awaiting orders of the adjutant general of the Army. The adjutant general may forthwith issue an order discharging such person from the military service for the convenience of the Government.

"Three official copies of the discharge order should be sent at once by the adjutant general to the local board. Upon receipt of these orders the local board should enter the name of the man discharged on Form 164A and forward Form 164A, together with two of the certified copies of the order of discharge, to the mobilization camp to which it furnishes men. The authorities at the mobilization camp will make the necessary entries to complete Form 164A, and will thereupon give the local board credit on its net quota for one drafted man."

Maximum British Prices for Superphosphates

An order of the Minister of Munitions which went into effect on Aug. 21 fixes maximum prices for superphosphates, according to *Commerce Reports*. These maxima are based upon the percentage of tribasic phosphate of lime rendered soluble in water, and vary from $22.50 per long ton for superphosphates between 15 and 16 per cent to $45.25 per ton between 44 and 45 per cent. Lloyd's List states that these prices, for all qualities, are for orders placed for delivery during December, 1917. In the case of orders placed for delivery during other months the prices are to be reduced or increased 1 shilling ($0.24)per ton per month according as the months precede or follow December, 1917.

For the purposes of the order "superphospate" means superphosphate of lime manufactured from mineral phosphate, but does not include basic superphosphate, bone superphosphate, dissolved bones, bone meal or bone compound, guanos, or compound manures.

Far Eastern Tin Supply

Present indications are that the Hongkong tin market will be stripped of its supplies in a few months as a result of the market advance in price in consuming countries and slow supplies from other producing countries, according to *Commerce Reports*. Exports for the first half of the present year are at the rate of about three times the highest record in the history of the trade and in much larger proportion compared with the average.

The exports, up to the limit of the total production, are merely a matter of price. While prices of tin the world over have been high for some time and have stimulated considerable exports from this field, the high exchange value of silver has operated against this field and in favor of others where the relations of local currency to gold was more favorable. The extraordinary demand at high prices has so denuded the Straits market, however, that buyers have turned to the Hongkong field perforce. Allowing for delays in supplies from the mines and for a modicum of speculation, there seems to be no question but that at present supplies of tin in the Far Eastern markets generally are barely equal to the demand.

Investigation of Defective Small-Arms Ammunition at Washington

Hearings thus far before the select committee of the House of Representatives to probe into the matter of defective small arms ammunition furnished troops under General Pershing and other units of the American armed forces have failed to disclose responsibility for the defects. The hearings are at present suspended while the evidence taken to date is printed, so that members of the committee can study the problem before them.

It has been developed in the hearings, however, through the testimony of Col. George Montgomery, commanding officer at the Frankford Arsenal at Philadelphia, where the rifle and machine gun ammunition in question was manufactured, that the arsenal continued to use a formula for the make-up of primers which was inferior to that in use by a majority of private manufacturers. This was done, the evidence discloses, in spite of the recommendation that it be discontinued.

There is a strong likelihood that the present special session of Congress will adjourn without the committee having reached the bottom of the ammunition probe. Experts have drawn the inference from the hearings also that the method of testing the various batches of cartridges turned out for small arms at the arsenal is not satisfactory, but are completely at a loss to suggest a better method.

It has been and is now the custom to take at random a number of cartridges from each batch turned out at the arsenal and test them by firing. On one day the results would be satisfactory, and only a small percentage of misfires and hangfires would result. On the succeeding day it was quite possible, the evidence showed, that a sufficient number of defective cartridges would be found among those tested to indicate that the entire batch manufactured on that day was unsatisfactory. Yet all were made up from the same formula and with the same materials. Expert witnesses before the probing committee attributed it to luck and nothing else that the testing cartridges on one day would test out with a low percentage of misfires and hangfires, with a much larger percentage of defective shells appearing on another day.

Colonel Montgomery has been the chief witness before the committee thus far. Some of his assistants from the arsenal have appeared, but have done nothing more than repeat his testimony in greater detail.

Some of the defects uncovered by use of the ammunition has developed, the evidence shows, from subjecting it to more rigid tests than are required by the regulations. Some of the ammunition furnished units of the various armed forces of the country has been allowed to stand in water or become saturated in some way and remain exposed for a longer period than they are supposed to stand and remain satisfactory. This had been unavoidable in a great many instances, however, it was shown.

The great fault with all the ammunition rejected by the Pershing forces and other commands of the army, navy, Marine Corps and National Guard is with the primers. This aspect of the situation has taken up more time than any other brought out at the present hearing.

It was developed that an inferior primer mixture has been in use for many months in the Frankford Arsenal, in spite of recommendations from Colonel Montgomery that it be abandoned, while private manufacturers of small arms ammunition were using better formulas. The primer formula to which Colonel Montgomery objected was one containing free sulphur as one of its constituents. Fulminate of mercury in place of the sulphur was urged, but for some reason not yet developed it was not adopted.

The combination of the free sulphur with potassium chlorate in the primer used at the arsenal worked well for some time, but the supply of potassium chlorate was not good after the United States was cut off from the German supply. Potassium bromate combined with the sulphur to deteriorate the shells.

Due to the testing method, a great many millions of shells were issued to army and navy units before it was known that they were defective. The defects to the chemical difficulties would not, of course, appear in newly finished shells at all, and it was largely due to these facts that the poor ammunition found its way out of the arsenal.

When the defect in the primer manufacture became known it was necessary to purchase millions of primers from one of the principal private manufacturers to maintain the war-time rate of production at the arsenal. Before it is possible for the arsenal so to change its formula and primer-making plant and system, it was necessary to make hurry demands on the private manufacturer for twenty-five million primers, then for ten million more, and later for another ten million.

Poor antimony sulphide figured to some extent in the defects found in the cartridges turned out. This, it was explained by Col. Montgomery and other army officers and experts attached to the arsenal, was due to the fact that the selection of this chemical was not on a good basis so far as purchases for the United States government are concerned, and the supply was well "picked over" before American government purchases were made.

Poor copper also was a factor, the evidence thus far taken has shown. The reason for obtaining or using the poor copper was not gone into in great detail, and has not yet been entirely cleared up to the satisfaction either of the committee or of the army.

On account of the deterioration of the shells after they left the arsenal—the deterioration due to the combination of free sulphur with the other elements of the primer formula—it was shown that it was impossible to locate bad small-arms shells before they were issued to the army or navy. Several samples of each batch issued are kept, however, with the dates of manufacture, the date of issue, and the organization to which issued. In this way it was possible to re-test samples of a batch said to be defective. This system and investigations following it, it was testified, enabled the arsenal authorities to discover that some of the ammunition had been exposed to greater rigors in active service than the specifications under which the shells were manufactured demanded. Further test of most of the batches questioned, however, developed the fact that deterioration in the primers, due to the use of the sulphur formula, was responsible for the high percentage of defective shells.

United States Chamber of Commerce Mobilizes American Business

American business was mobilized at Atlantic City, N. J., on September 17 to 21, when the leaders in every industry in the United States gathered there to see how the industrial, commercial, and financial resources of the country could best be utilized to aid the government in bringing the war to a successful conclusion, as well as aid business itself to come to a definite understanding as to its future in connection with the conduct of the present war.

Some of the best work done at the convention, aside from the speeches which inspired those who were present, was done by the Committee on Resolutions, which included men in every line of commerce, industry and finance, as well as men from every section of the country. It was freely pointed out in the convention, which was called the War Convention of American Business, that no committee on resolutions in any assembly of the Chamber of Commerce of the United States had ever included a more representative body of American Business than the committee which served so laboriously at this Atlantic City convention.

The background of the convention was that American Business since the declaration of war with Germany, and since the competitive buying of supplies in the United States for the Allies, for the United States, and for private business, had thrown American industry into chaos.

The situation was very clearly defined by Mr. Waddill Catchings, chairman of the Program Committee of the convention, and who is also chairman of the Committee on Co-operation with the Council of National Defense, on behalf of the National Chamber. Mr. Catchings, formerly a president of a number of iron and steel companies, left those industries upon the declaration of war, declaring he did not care to make money out of the war, and placed his services at the hands of the government in Washington, so that because of his previous experience in the industries in which he has been connected, and because also of his experience in close touch with the Council of National Defense, he was in the opinion of the delegates to the convention well qualified to analyze the present condition of business as it affects government and private industry jointly.

Newspaper reports did not carry a complete report of Mr. Catchings' address to the convention, nor of the resolution which was adopted by the Chamber of Commerce of the United States at the War Convention which was inspired by Mr. Catchings' address and the background which made necessary the calling of the war convention. Never in the history of American Business have such resolutions been passed at any convention such as that of the National Chamber just ended. Leaders of industry, commerce and finance, supported by less known men from every section of the country, declared in their resolutions that at the earliest possible moment all the purchasing of the government for the war should be concentrated in one body. They declared for the first time in the history of American industry that it is right, proper, and necessary that the government should have the power to fix prices on all materials needed for the conduct of the war as well as all materials affecting the public interest for the government itself and for the public at large. It was declared that the government should by right of necessity have the power of fixing the priority of shipments. It was declared that American business is ready for heavy taxes, for the dissipation of its savings, and that it is ready to turn over its plants to the government, under government control if necessary, and do any and every other thing which may be necessary for the successful conduct of the war.

Important Waterpower Resolutions

One of the features of the convention was a resolution in regard to waterpower which was discussed by S. A. Osborne, vice president of the Westinghouse Company. There was an extended discussion upon the subject, most of which tended toward committing the Chamber of Commerce of the United States to an attempt to urge upon Congress the desirability of the enactment of some of the waterpower bills which have been pending in Congress for several years. It was declared that Congress should without delay enact this legislation, especially the legislation pending which would develop the waterpowers at sites now under federal control. There were two resolutions upon this subject, the other one, tending especially toward irrigation projects. The first resolution requested that the directors of the Chamber of Commerce of the United States be asked to appoint a special committee to investigate the present need of waterpower development and the character and extent of legislation required and to report to the National Chamber as soon as possible. The Committee on Resolutions suggested that the convention endorse the request that this resolution should be referred to the Board of Directors of the National Chamber; and the Committee on Resolutions also suggested, which suggestion was also endorsed by the convention, that the other resolution on waterpower should be referred to the Board of Directors.

It is understood in Washington since the convention adjourned, that a special committee on waterpower will be appointed in accordance with the suggestion in the resolution which asked for such a committee and into the hands of this committee-to-be, no doubt, will be committed the other waterpower resolution dealing with irrigation.

The convention, according to those who were present, was an inspiring occasion. James A. Farrell, president of the United States Steel Corporation; John D. Ryan, president of the Anaconda Copper Mining Company; Henry Bruere, vice president of the American Metal Company; E. H. Huxley, of the United States Rubber Company, and many other leaders in industry addressed the convention. Herbert C. Hoover, the United States Food Administrator, delivered an address in which he spoke almost wholly of food, but those who are familiar with the so-called Food Bill which was passed by Congress realize that the things he said could be done by the government in regard to food can be done by the government very largely in regard to fuel. He described the complete control of the government over food. Very strong resolutions of support for Russia were passed, and especially in regard to further financial support for that new democracy.

Outline of Present Business Conditions

The present chaotic situation in American business and the steps necessary to bring order out of confusion were well presented in an address by Mr. Waddill

Catchings. We give herewith the principal features of his address.

The committee on co-operation with the Council of National Defense, of which I am chairman, has for the last few months been in intimate contact in Washington with the great industrial problems which have arisen as a result of the large purchases which our Government is making. It is said that our Government will expend for war purposes for our armies and for the allies during the next year $19,000,000,000. You get some idea of the effect on business of this great demand if you have in mind that the entire turn-over of all the subsidiaries of the United States Steel Corporation, the gross volume of their business in the year 1916, the Carnegie Steel Company, the American Steel & Wire Company, the Tennessee Coal, Iron & Railroad Company, and all the rest—the entire value of their gross turn-over was $853,000,000.

Our Government is therefore going to lay a demand upon business which is more than twenty times the output of all the subsidiaries of the United States Steel Corporation.

You have an opportunity at home of seeing the effect on business of these great purchases, the effect of the withdrawal of material and labor. These interests essential to the industrial fabric are unable at the present time to secure the materials which they need. The interests which are not essential to the industrial life are faced with the great problem of what they are going to do during these times to carry their structure from the present over into the future.

High Prices Due to Competitive Bidding

The result of the competitive bidding by the Government for the vast quantities of materials and supplies which they need, and of the competitive bidding by business for what is left, has produced high prices. These high prices have produced great discontent throughout the country. Our people have not viewed with unconcern the acquiring of great riches in this time of national sacrifice and distress. There are great labor difficulties arising in all sections of the country. We are having here the same experience which England had in securing the exceptional effort of labor when an indirect effect of that exceptional effort was the creation of great riches.

These are problems which are developing throughout the country, and they are problems which it is the expectation of the program committee and of the committee on co-operation with the Council of National Defense, will be discussed fully in this meeting. They are problems not only of the purchase of supplies by our Government, but the purchase of the supplies in such manner as not to interfere with the essential industrial life of the nation; the purchase of these supplies in such a manner as not to unsettle established social and economic conditions.

You know that when business men are told that they should not charge a high price for materials and supplies, that that is entirely ineffective unless some action is taken to create a different condition. As long as there is a great demand, so long will prices rise; and it is idle for us as business men to respond to the patriotic addresses that are made unless we carefully discuss how we can carry into effect the ideas that are expressed and to make them effective.

It is for you to determine if this country has vested in our Government at Washington sufficient power in times of peace to settle these extraordinary problems which have arisen in connection with the war as a result of these vast purchases. You have in mind, no doubt, that the effort of our Government in connection with the purchases of munitions of war is focussed on the war industries. It is a great disappointment to us that Mr. Scott, the chairman of this board, has not been able to be here to-day to set forth to you the great work which the board has done. It is for you to determine whether this board, with the powers it has under existing statutes, can meet the situation when it is developing. In this great democracy of ours powers must be vested in the Government before the Government can act, and it is not possible for the authorities in Washington to act in regard to the problems existing as might seem best to them. It is only possible for them to act in accordance with the statutory power which has been given to them. It is for you to determine here whether the War Industries Board and our Government at the present time have power necessary to solve these great problems which are arising from this unprecedented demand upon business.

You no doubt have in mind that the War Industries Board was created by the Council of National Defense; that the Council of National Defense has no authority under the law to act; that the Council of National Defense is a body that was created in time of peace to investigate, report and give advice. The War Industries Board has been created by that body. It can have no power which was not possessed by the body which created it. The War Industries Board is rendering great service to-day in advising Government officials in bringing centralization to the Government purchases, but the purchasing for the Government to-day is being done just as it was done in times of peace by the many bureaus and departments of the War Department and of the Navy Department. Independent purchases are being made to-day by the signal corps, the engineer corps, the naval corps and all of the various quartermasters. The War Industries Board is doing all it can to bring about co-operation between them, but any careful study of the situation in Washington will lead you, I think, to the conclusion that what they are able to accomplish, however great it may seem, is not great in comparison with the work which is to be done.

Creation of Government War Board Necessary

The committee of which I am chairman has been studying the situation in Washington for months, and I say to you without hesitation that without loss of time our Government should be given power to create a war board similar to the minister of munitions in England. This should be a board which would assemble under one control the trained buyers of the various departments of the Government. It should be drawn from the various competing bodies and gathered together; but these competing bodies of Government officials should be reenforced by men from civilian life. Most of those men are probably in Washington at the present time advising the Government as best they may, but these men should be no longer advisors; they should be in the actual service and doing actual purchasing for the Government.

The Government is in contact with business to-day on a scale never heard of in our Government before. Army and navy officers who are trained with special work and who have had some experience with special buying in the past are called upon to deal with these enormous problems. Our committee says unhesitatingly that these men should be relieved for service at the front, except such of them as are necessary to retain experience from what has been done. All who have experience should be called into the Government service. Such a board would have to have power to determine prices when negotiation between buyer and seller can no longer take place because of the unprecedented demands for material; and as to those materials which are necessary for the national defense, those materials which are necessary for the preservation of our essential industrial life, where negotiations between buyer and seller can no longer be had, our committee says unhesitatingly that the Government should have authority to determine the price upon some fair basis. Such a body would have to have power to determine priority, the order of distribution of the available supplies.

We say to you that you cannot expect the material of our country, which is not equal to the entire demand, to go where it is most needed into national defense or for the preservation of our essential industrial life by mere competitive bidding. We say to you that the experience that has been acquired should be made use of here. We say to you that a careful examination of the work that has been done by the ministry of munitions, the manner in which they have had to determine priority, the matter in which they have to determine prices, the effect of all that upon the British life, the orderly manner in which business is run in Great Britain to-day, will convince you, upon thoughtful investigation, that it is necessary.

Our committee is glad to say that the independent investigation of the price control committee recently formed has led them to the same conclusion. The Chamber of Commerce appointed a committee on which were important men from all sections of the country. They represented all phases of business life. They came to Washington without knowledge of the situation there, with probably as many different points of view as there were different men on the committee. They sat down and studied the situation very carefully. They threshed out these problems and worked together upon them for days, and they came to a unanimous conclusion. The Wall Street man and the farmer, the lawyer and the manufacturer, the distributor and the merchant came to a unanimous conclusion, and that is carried forth to you in Referendum No. 22.

Our committee says to you that no delay should be made in reaching conclusions of this sort. It is a common statement in Washington that our American people are not going to wake up to what is meant by the war and what it really means to bring order in business until the casualty lists begin to come in. My committee says to you that you have here the opportunity in this convention of facing the facts as they actually are, of studying those facts and discussing them among yourselves and of reaching conclusions at a time which may save many dollars and may save a great many precious lives.

Objections to Government Regulation Answered

If you say that the Government should not interfere with business, our committee says that the answer is that the purchasing of $19,000,000,000 of material and labor is an interference with business, and that the suggestion is not that there be no interference, but that there be orderly interference, and not disorder.

If you say that the loss of trade should be taken into consideration, our committee says that the answer to that is that when the entire industrial life of our nation is concentrated upon the single purpose of winning the war, there is no loss of trade.

If you say that the machinery of the Government should be developed and used for the purposes of the War and Navy Departments, we think the answer is that these are temporary problems, that business is asked to give the Government great power temporarily; that the situation which we are asked to meet exists only during the war, and that therefore a temporary structure should be created so that at the end of the war we can so far as possible return to normal conditions.

If you say that the situation is too big, too complicated, that our Government cannot undertake the regulation of prices or the regulation of priorities, we say to you that chaos exists in business to-day, and that order must be brought out of that chaos. If our industrial energy is to be centered behind winning the war, these problems must be solved.

We believe it is entirely appropriate for this convention to discuss these matters. Under our democratic system, the necessary authority and power must be conferred upon our executive officers. These are problems with which you are familiar, if any men are familiar with them. You know the conditions existing throughout the country. You know whether our railroad machine shops have men which they need and whether those men have been drawn to go to munition plants. You know whether the public service companies of the country are able to bid for material and supplies at the present time. You know whether labor is discontented and whether there is orderly conduct of business at the present time.

A clear illustration of the situation is furnished in the manner in which the engineering department, the ordnance department, the medical department, the quartermaster department and the navy department are doing their work. The private concerns are doing work on Government "cost plus profit" contracts, and all are working independently. All are competing one with another for labor and for material.

You are the men who know whether those conditions exist throughout the country. Our committee says it is not right for American business to wait for the United States at Washington to suggest these problems which are to be worked out. There are enormous problems in Washington. The problems of business are but a portion of those problems. You cannot expect the Government officers to recognize our problems with the same ease and facility that you can become acquainted with them.

Our committee believes that this convention offers a very great opportunity; that if American business men in this mass meeting discuss these problems, get a realization of the remedy which may be applied, you

can bring order out of this chaotic condition at a much earlier date than it will be brought by the natural course of events. That can be done if you approach our Government and point out that business is willing to submit to control in these times; that you do not insist upon full freedom of action when winning the war is at stake. If that is done, co-operation can come about between business and the Government which cannot exist at the present time. Business will no longer be on the opposite side of the table in any negotiation. Business can sit side by side with the officials of the Government in an effort to solve these problems.

These are the problems which it is the hope of the committee you will discuss during these days. These are the problems as to which the committee hopes you will pass resolutions which shall give expression to the National Chamber of what action business men desire taken.

Important Resolutions Passed

The great war convention of the Chamber of Commerce of the United States, characterized by the thousands who were present as the greatest convention in the history of the organization, came to an end with the passage of some of the most remarkable resolutions ever passed by American business.

A complete digest of these documents would be too lengthy for presentation, and only the most pertinent can be mentioned. The following "Declaration of the War Convention of American Business," sounded the keynote.

"The people of the United States, in defense of the Republic and the principles upon which this nation was founded, are now taking their part in the world war with no lust for power and no thought of financial or territorial gain.

"The issues at stake in this stupendous struggle involve the moral ideals and conception of justice and liberty for which our forefathers fought, the protection of the innocent and helpless, the sanctity of womanhood and home, freedom of opportunity for all men and the assurance of the safety of civilization and progress to all nations great and small.

"Speed of production and mobilization of all our national power mean the saving of human life, an earlier ending of the designs of autocracy and militarism, and the return to the peoples of the earth of peace and happiness.

"Undismayed at the prospect of great taxes, facing the consumption of its accumulated savings, American Business without hesitation pledges our Government its full and unqualified support in the prosecution of the war until Prussianism is utterly destroyed.

"Assembled on the call of the Chamber of Commerce of the United States and representing more than half a million business men and every industry in every State in the Union, this Convention promises to our people that Business will do all in its power to prevent waste of men and material and will dedicate to the Nation every facility it has developed, and every financial resource it commands on such terms and under such circumstances as our Government shall determine to be just."

The following important recommendation was made regarding water power legislation:

WHEREAS, the scarcity of coal and other fuels during the past year, with the resulting disastrous effect on every branch of commerce and industry, calls renewed attention to the great importance of developing at the earliest possible day unused water power in order to make available for public service an inexhaustible power not requiring the consumption of exhaustible fuel, and,

WHEREAS, Increased use of water power, because it furnishes a cheap and reliable power of general application, reduces the drain on our stores of mineral fuel, which when consumed can never be renewed, and thereby relieves a great stringency bearing on national defense due to the imperative need for fuel for both land and water transport and the manufacture of war supplies, Be it therefore

RESOLVED, That Congress should without delay enact legislation necessary to the early development of water power at sites now under Federal control, on terms which will advance and protect the public interest. Also

RESOLVED, That the directors be requested to appoint a special committee to investigate this present need of water power development and the character and extent of legislation required and report to this Chamber as promptly as possible.

Briefly, the resolutions passed by the convention were as follows:

(1) A general resolution pledging the support of business to the war as given above.

(2) A resolution declaring that at the earliest moment all the purchasing of the government should be concentrated in one body and that the government should have the power to fix prices on all material needed for the conduct of the war as well as all materials affecting the public interest, for the government itself and for the public at large.

(3) That employers and employees should not attempt to change existing standards of work during the period of the war.

(4) That a federal board appointed by the President to adjust disputes during the course of war. That there should be no strikes or lockouts during the adjustment of such disputes. The committee on resolutions refused to report a resolution that would try to tell labor what it must do and the convention took the attitude that American business should merely invite the co-operation of labor.

(5) A resolution of sympathy with Russia was passed.

(6) The co-operation of the retail merchants of the United States to the Commercial Economy Board was pledged and the usefulness of the employment service for the Department of Labor was endorsed.

(7) The convention endorsed the action of the directors in creating a foreign commission to proceed abroad and study and report upon the means whereby business may adapt itself to the problems that will arise during and after the war.

(8) The convention requested that every organization should call a war meeting before Nov. 1 to take to these organizations the lessons of the convention.

(9) The daylight saving plan, it was declared, would conserve the nation's supply of coal.

(10) The improvement of public highways for military roads and in order to move foodstuffs economically was moved.

(11) The United States Government was urged to take whatever action may be necessary to keep the American dollar on a par with exchange in every other country of the world. The Chamber urged the business men of the country to promote the sale of future Liberty Loans and especially urged that employers assist their employees to subscribe to such loans.

Annual Meetings of Institute of Metals and American Foundrymen's Association

Enthusiastic Gatherings Discuss Important Aspects of Metallurgy

A large and enthusiastic gathering of engineers and foundrymen interested in non-ferrous alloys occured at the annual meeting of the American Institute of Metals held in Boston, during the week of Sept. 24, 1917. The first day was held as a joint meeting with the American Foundrymen's Association, and its account will be found on page 382 under that head.

The technical sessions occupied the mornings thruout the week, the afternoons being occupied by various social affairs and plant visitations, such as a boat ride about Boston Harbor, American League ball game, theatre parties, luncheons and banquets, a trip to such interesting places as the West Lynn plant of the General Electric Co., Waltham Watch Co., Massachusetts Institute of Technology, and a numerous list of notable foundries and industrial plants. The Annual Banquet was held at the Copley-Plaza Hotel on Thursday evening, and as usual was one of the great features of the annual meetings. John A. Penton, of Cleveland, delivered the main address in which he discussed conditions in France during the war, he recently having been privileged to spend three months inspecting munitions works, steel plants and rolling mills. Judge Charles F. Moore also gave a very clever talk on "Dollars and Sense."

MELTING PRACTICE, ESPECIALLY IN ELECTRIC FURNACES

The first technical session of the Institute covered Melting and Casting. The present acute situation in crucibles was not only reflected in papers by **A. V. Bleininger** of the Bureau of Standards on "Raw Materials Used for Crucibles," and **M. McNaughton** of the Jos. Dixon Crucible Co. on "The Crucible Situation," but also by two other notable papers on electric furnaces for melting high-zinc alloys.

Mr. McNaughton took issue with Prof. Bleninger's statement that the question of the manufacture of satisfactory crucibles from American clays and graphite could be solved in the laboratory. Even admitting the enormous importance of such researches in indicating the proper procedure, still the final test must always come in the actual manufacture and use of the crucibles on an industrial scale. Owing to the great difficulty of making crucibles with clays and plumbago other than the time-tried imported materials, makers had been insisting that melters do as much work as possible in the smaller-sized containers. Even so, little decline in the demand and use for large sizes was noticeable from the rolling mills, consequently he thought the average size of crucible in use is about the same as before the war.

Mr. G. H. Clamer of the Ajax Metal Co., described the melting of yellow brass in a new form of induction furnace, developed from the Snyder type, and called the Ajax-Wyatt. These furnaces which have been installed in five plants in America contain an upper chamber, mounted on trunions and with spout and cover very much like any tilting crucible furnace. However, a triangular casing is bolted to the bottom, which contains a rectangular passage leading from the sides of the furnace laboratory and meeting at the bottom, much like the letter V. Thru the center of this triangle is placed the core and primary of a single phase transformer, the secondary circuit consists then of molten metal in the V-trough and chamber above. The furnace is started with enough molten metal to fill the channels and bridge across their top; the current induced by the transformer action will cause rapid circulation by pinch, motor, and Joule effect, which will transmit the heat generated mainly in the trough up into the crucible for melting additional cold metal. The design of the furnace is such that the circulation induced by the heating currents is sufficient to replace hot metal with cooler before it is locally superheated beyond the boiling point of the zinc content. By the very nature of the furnace, however, it is almost essential to operate continuously, with a uniform mixture; since the power input is practically uniform as long as a molten metal circuit remains, which indeed is reserved in the furnace after each pouring.

PRESENT STATUS OF THE BRASS MELTING FURNACE

A very inclusive paper by **Dwight D. Miller** on "The Electric Furnace and Nonferrous Metals," excited much favorable comment. Mr. Miller's paper noted the very rapid rise of the electric steel furnace in America; the Halcomb Steel Co. having built and operated the first in the western hemisphere in April, 1906. Up to 1914 there were only 19 furnaces installed, and some of these were not operating. The first of 1915 saw 41 electric furnaces, by 1916 the number had grown to 73, while on Jan. 1, 1917, no less than 136 electric furnaces were in use melting steel or under contract. The total number then in use thruout the world in steel works, according to the best information attainable, was 471, of 17 different makes.

After a section of the paper in which he classifies and briefly describes the more important furnaces in use, he points out the many obvious advantages of the electric furnace in the non-ferrous field, the reason why this type can make progress against cheap coal fuel, being of course that the heat cost is but a small percentage of the total cost of the finished product. Then too, the efficiency of heat transfer in a well designed electric furnace is so much better than that of the ordinary melting hole that the cost per B.t.u. hardly tells the total story. On the other hand, ordinary steel-melting furnaces do not handle alloys high in zinc like the normal brasses, without a high metal loss. This not only costs money, but the zinc vapor produced causes great electrical disturbances, and in many cases prevents the further operation of the furnace.

Mr. Miller listed the following furnaces as having been designed and under experimentation: The Gillett Furnace, of an indirect arc type; the General Electric Furnace, of a "smothered arc" type; the Conley Furnace, which uses the crucible as the resistor; the Northrup furnace, an induction furnace using an oscillating current of high voltage; the Hering "pinch effect" furnace; and the Bennett furnace, now being developed by the Scovill Manufacturing Co.

No less than five different types of electric furnaces are now melting copper-zinc alloys, with variable results, as follows: The Ajax-Wyatt furnace, described by Mr. Clamer as above; the Foley furnace, similar to the first mentioned; the Bailey furnace, described in METALLURGICAL AND CHEMICAL ENGINEERING, July 15, 1917, page 91; the Rennerfelt arc furnace; and the Snyder induction furnace. This portion of the article giving details of practice on zincy metal is reserved for future publication in full.

In the discussion of the paper, **Dr. H. W. Gillett** said that he was unable to present definite figures regarding the furnace which he was trying to develop because it was not yet in definite shape. However, it had melted about 100,000 lbs. of metal with variable results, altho in every trial in melting scrap 2 or 3 per cent more metal reached the ingot than the best coke practice. Using alloys containing up to 30 per cent zinc the ingot was one per cent or more higher in zinc than in coke melting. The power consumption was very good, and the principal difficulty was that the zinc distilling from the bath tended to condense as powder at the electrode openings, finally freezing these in place and preventing their adjustment.

W. H. Parry of the National Meter Co. described in a humorous way the barrels of grief he encountered in trying to operate a reclamation plant built by a firm of near-engineers who couldn't tell him how to run it. After telling of his many failures to produce any metal using various fluxes, he at last acquired a furnace man from a metal refinery, who at last was able to produce metal without the use of flux of any kind, containing nearly all the copper, tin and lead and about half of the zinc contained in the spillings, turnings, slags, and drosses charged.

NEW ALLOYS AND THEIR USES

The second technical session brought forth several interesting papers. "The Present Status of Tin Fusible Plug Manufacture," by **Dr. G. K. Burgess** of the Bureau of Standards was read by title. Mr. **Elwood Haynes** described the invention and perfection of his alloy "Stellite" in a very interesting address. Mr. Haynes had with him the various pieces of cutlery and hardware which he exhibited at the recent meeting of the American Chemical Society, and which excited a great deal of interest.

Mr. **H. J. Roast** of Jas. Robertson Co., Ltd., described the manufacture of "Shrapnel Bullets." The English government requirements are for an alloy of 12⅛ per cent antimony, 87⅛ per cent lead, with a variation of ± 0.25 per cent in composition. The balls are ½ in. in diameter, and weigh 41 to the pound; the size and shape being very closely inspected. After trying extrusion of cast bars, it was found that casting in water-cooled molds, 150 at a time, gave a more uniform ball, both as to size, weight and chemical composition. In this connection the author emphasized again the need of a standardized and reliable method of analysis for antimony, as the probable error in some methods was found to be greater than the tolerance allowed in the specification.

The discussion of Mr. Roast's paper brought out the fact that constant stirring was essential to prevent segregation, even in eutectic alloys. Stirring which caused rising currents is essential, as rotating currents actually cause segregation. Improperly melted, the shrapnel metal segregates so badly as to vary from 11 to 19 per cent antimony.

"Recent Industrial Uses of Aluminum" were noted in a short paper by **F. G. Shull** of the Aluminium Co. of America. He mentioned the use of plain foil for wrapping candy, lining food containers of wood, paper or metal, and as seals for glass jar caps and bottled goods. Quantities were being absorbed in the construction of electrical condensers. The development of the art of printing and embossing such foil had been interesting, and was accounting for a large increase in consumption. The perfection of autogenous welding had opened up a wide field in the chemical, brewing and food industries, in fact, everywhere where one-piece metallic, non-rusting containers for liquids were desirable. Seamless tubing had also been produced for such service. Where drawn pure aluminum rods had been extensively used for stock in automatic machine products a high-aluminium alloy which could be rolled into rods was being substituted, the more thorough mechanical kneading of the rolling process giving a much more homogeneous and desirable metal. A die-cast piece, either plain, or with subsequent hydraulic compression, is now being substituted for automatic machine products involving the production of a large amount of scrap or turnings. Compressed castings have been extensively used in time devices for shrapnel, being of very high strength, absolutely sound, and easily machined.

Mr. **A. L. Stillman** read a paper on "The Briquetting of Non-ferrous Light Metal Scrap," in which he stated that fluxes or binders should not be used in metal briquettes unless, as in bronze, the highest available pressure would not cause a cohesion, metal to metal. Most white metals and brasses, however, if properly briquetted, can be welded together into "heavy scrap" having a density from 65 to 85 per cent that of the corresponding ingot metal. This is effected by slow multi-stage compression, the first squeeze at a moderate force interlocks the fragments and eliminates the entrapped air, while the following final pressure of 33,000 lbs. per sq. inch forces points of the particles within the range of inter-molecular forces, actually forming a weld.

METAL-TESTING SESSION

A number of important papers were read on the various physical tests of alloys, which space limitation admits of barely more than a mere enumeration. Mr. **W. M. Corse**, secretary-treasurer of the Institute, read a paper on "Comparative Tests on Test Bars and Actual Castings." **E. W. Hagmaier** of the Superior Rubber Co. read an interesting paper on speedy analyses of brass, bronze and babbitt, especially designed for routine, commercial determinations. The methods were especially interesting, as the author explains the de-

tails of manipulation which really develop the speed in chemical analyses.

The co-operation of the Bureau of Standards with various foundries were shown in two interesting papers, one by **C. P. Karr** on "Tests of 88-8-4," and another by **H. S. Rawdon** on the "Corrosion of Brasses of the Muntz Metal Type." Mr. Rawdon pointed out that brass of the type 60 copper and 40 zinc (Muntz metal) which is used commercially in a variety of forms, e.g. wrought bolts, sheathing, condenser tubes, extruded forms, etc., often show a kind of deterioration by which the metal changes its color to copper-red and becomes very weak and brittle, although the shape, and size apparently remain unchanged. This change of properties is due to a selective corrosion of the alloy, which has a duplex structure, when exposed to the action of some electrolyte—particularly sea water. This type of corrosion has been recognized by manufacturers and users of brass for some time. The study of such types includes bolts, boat sheathing, condenser tubes, and parts which were corroded while under stress. The examination of the microstructure shows the method of the attack; the zinc-rich constituent being electrolytically "leached out" leaving a skeleton of pulverulent copper in its place so that the piece becomes very weak and brittle. Later, the second constituent may be attacked so that the whole specimen is converted into pulverulent "copper"—the sample becoming so weak that it can be broken into fragments in the fingers. Conditions which accelerate this type of corrosive attack are: The microstructural composition of the alloy, contact with strongly electro-negative metals, the effect of certain adhering deposits of basic zinc chloride resulting from the corrosion, the thoroughness of the annealing which the sample has previously received, the temperature of the electrolyte, and the stresses to which the specimens are subjected during the corrosive attack.

METALLURGY AND METALLOGRAPHY

The session on Friday, devoted to Metallurgy and Metallography was of the greatest scientific interest. Mr. **Zay Jeffries** of the Aluminum Castings Co., read an important paper on "The Amorphous Theory in Metals"; while Mr. **H. M. Williams**, of the National Cash Register Co., described a long research into the causes of a very bothersome property of certain zincy die castings—namely, their slight expansion with age. Both of these papers we hope to present in extenso at a later date.

Mr. **K. C. Li** of the Wah Chang Mining & Smelting Co., read an interesting paper on "The Metallurgy of Antimony," in which he described the methods of production of crude antimony, antimony oxides, and metallic antimony. A number of interesting uses were listed, it entering as metal into the composition of Babbitt metal, type metal, Britannia metal, battery plates, toys, siphon tops, cable sheathing, shrapnel bullets and hard lead. Antimony compounds are used in enamels, rubber vulcanizing, pigments, glass making and safety matches. **Prof. D. J. Demorest** described experiments which he had performed in his laboratory at Ohio State University leading to the electrolytic production of antimony direct from crude antimony, or Sb_2S_3, eliminating the 20 per cent waste at present remaining in the residue. He concluded that stibnite dissolves easily in NaOH or Na_2S from which antimony in a high state of purity is precipitated with a current efficiency of about 76 per cent, a voltage of 2.7, giving a power cost about equal to that of the electrolytic production of zinc. The solution must be regenerated or renewed when one pound of antimony has been produced per pound of NaOH used. The electrolyte may be reduced to Na_2S but the practicability of this has not been tried.

Mr. R. A. Wood's paper on "Brass Rolling Mill Alloys" emphasized the necessity of using the purest copper and zinc, of making sure that the alloy is kept pure, and of the extreme care necessary in annealing. The paper gives a most valuable list of analyses of the various trade-named metals.

American Foundrymen's Association

Twenty-second Meeting

The American Foundrymen's Association held a very successful meeting in Paul Revere Hall, Boston, during the week of Sept. 24. In connection with their technical sessions, a very interesting and instructive exhibit of foundry appliances was held in Mechanics' Hall. While there was considerable disappointment evinced at the decision of the Government that it could not spare the time of a trained officer to collect an exhibit of munitions with which the American foundrymen could become acquainted, yet the exposition, with its 160 odd exhibitors showed a considerable increase in number and volume over the last, held in Cleveland in 1916. The visitor is struck with the number of exhibits devoted to the finishing department—sand blasting and grinding equipment especially. Labor saving equipment of all sorts were much in evidence; man saving safety-first applications were also prominent. As an earnest of the sure trend in foundry evolution appeared several exhibits of chemical and metallurgical- and mechanical-testing materials.

JOINT MEETING WITH INSTITUTE OF METALS

On the first day of the convention was held a joint meeting with the American Institute of Metals, when the usual welcoming addresses, and those of **J. P. Pero** and **Jesse L. Jones**, presidents of the societies, were delivered. The report of the Board of Directors mentioned the fact that they offered in the spring to pay the expenses of a committee of their members to the allied countries to study their methods of producing castings for shrapnel and other munitions. The ordnance experts of the United States Government, however, did not think it probable that cast-iron could be used advantageously in the manufacture of shrapnel, and if they had been used, it had been from necessity rather than choice. It was therefore not practicable to arrange for an official visit to Europe for that purpose.

A. O. Backert, secretary-treasurer, reported that the total membership had increased to 1017, but that the decline in the number of associates had steadily declined ever since the Associated Foundry Foremen were merged. **C. W. Johnson** of the Westinghouse organization also read an interesting article on "Fire Prevention in Large Industrial Establishments."

GENERAL SESSION

On the second day of the meeting, **W. J. Kibby** read an interesting paper on "How Character Analysis Solves the Man Problem," pointing out the economy of placing a man in the right place by studying his physical fitness and mental equipment. He presented some of the fundamentals of such character studies. The Committee on Industrial Education reported that in considering the question of training of molder's apprentices, it had concluded that it would be well to establish experimental classes of actual apprentices, and the director of vocational work in the Chicago schools had promised to conduct such a course.

MALLEABLE IRON SESSION

A very interesting session on Malleable Iron was held on the fourth day. Among others, **A. D. Pratt** of the Babcock and Wilcox Co., discussed "The Theory of the Modern Waste Heat Boiler and the Possible Application to Malleable Furnaces." The theory of such installations has already been covered in METALLURGICAL AND CHEMICAL ENGINEERING (Vol. 15, p 696, e.s.). Mr. Pratt said that on the basis of experience in other fields, it is possible to compute the performances of a modern waste heat boiler from the records of coal burned, and exit gas temperature and analysis. A 15-ton furnace at the McCormick works of the International Harvester Co. had a 400 hp. vertical water-tube boiler installation representative of early practice. The performance of the furnace is plotted in curves showing a wide range at different portions of the melting cycle—and might be increased by 16.5 per cent with smaller heating surface in a modern design.

Mr. Joseph B. Deisher of the T. H. Symington Co., discussing "Carbon Losses in Malleable Iron Annealing," deals with many of the factors entering into the annealing of malleable castings in muffle and pot ovens. The safe annealing temperatures are from 1450 to 1650 degrees Fahr. for pot ovens and from 1500 to 1700 degrees for muffle ovens. Mr. Deisher believes that the 60 hours usually considered necessary to completely dissolve the iron carbide are not actually required and that the best practice is to bring the castings to the highest temperature at the beginning of the anneal, such temperature to be held until the iron carbide is dissolved, and then drop to 1400 degrees, which is considered favorable for the precipitation of the graphitic carbon. In a comprehensive discussion of the advantages and disadvantages of the pot and muffle ovens, the author concludes that the conversion rather than the removal of carbon in the anneal produces ductility.

Joseph Harrington and **W. R. Bean** both read interesting papers on the application of pulverized fuel to the melting of malleable cast iron. In spite of its manifest advantages, however, malleable foundrymen are reluctant to take up powdered coal in earnest. "It is certainly a case where precedent is wrong," the author concludes, "and the reluctance of foundrymen to take the first step will probably be balanced by their eagerness to fall in line just as soon as the pioneer has completed his installation."

GRAY IRON SESSIONS

In sessions devoted to gray iron castings, **T. Mauland** of the International Harvester Co. discussed "High Sulphur in Soft Gray Iron," in which he said that in spite of the fact that high sulphur is almost universally considered detrimental to good results in the foundry, he has observed that castings up to 0.12 per cent will sometimes be good, strong and soft. At other times with the other elements the same, the castings will be hard with sulphur less than 0.09 per cent. It may be inferred, therefore, that sulphur is not the determining element in the hardness of gray-iron castings. He concludes that sulphur in itself is not nearly so bad as it has been painted, and believes the reason good castings sometimes are obtained with high sulphur iron lies in the fact that the oxygen in such cases usually is low. **L. M. Sherwin,** Brown and Sharpe Mfg. Co., read a paper on "The Seasoning of Gray Iron Castings." After describing microscopical tests on a series of annealed bars he states that many important questions regarding this matter have not yet been satisfactorily answered and further experimentation is essential for their elucidation. **Edgar A. Custer** in discussing "Cast-Iron Shells in Permament Molds," pointed out the superior effectiveness of the cast-iron shell in attacking earthworks, that the efficiency of a shell fired against troops is dependent almost entirely upon the character of its fragmentation, in which particular cast-iron shells have been shown to be much more satisfactory than forged-steel projectiles. Cast-iron shells, with proper foundry procedure, also can be easily made in enormous quantities. France is making over 1,000,000 rounds a day at present in dry-sand molds. A steel forging for a 4.7-inch shell costs over $7; a cast-iron shell of similar size can be made for a little over $2. With these advantages in mind, the case for the cast-iron shell seems complete, provided proper foundry practice can be secured so the shells will be of uniform and satisfactory quality. To achieve this result, the permanent mold is recommended, and the details of making such shells were discussed.

STEEL CASTINGS

In the sessions devoted to steel castings, Major C. **M. Wesson,** Watertown arsenal, presented an important paper on "Steel Castings for Ordnance Construction," which we hope to publish in full in a future issue. A paper on "A New Method of Burning Crude Oil" was read by **W. A. Janssen,** Canadian Steel Foundries. After a brief resume of the early development of crude-oil burning apparatus, Mr. Janssen described a new system in which the air is preheated and subsequently mixed with the oil in definite proportions, creating a combustible gas. The gaseous product is forced into the furnace under pressure. The preheater is cast iron, and is provided with flues for the passage of the waste gases which form the source of heat. The vaporizer is a hollow cast-iron fitting provided with baffles to insure an intimate mixture of oil and air, and the thorough vaporization of the former. With this type of burner, Mr. Janssen stated, that oil economies of 40 per cent had been realized.

The great interest in electric melting furnaces was shown by a symposium of four papers on this matter by **John A. Crowley, Douglas Walker, C. R. Messinger** and **E. L. Crosby.**

Boston Meeting of American Chemical Society

In the report of the first two days' meetings of the American Chemical Society in Boston, given in our last issue the opening address of Dr. R. C. Maclaurin, president of the Massachusetts Institute of Technology was accidentally omitted. Dr. Maclaurin in welcoming the society to the Massachusetts Institute of Technology said that the man in the street may not pay much attention to the proceedings of the society, but none the less it is probably true that no body of men similarly associated is capable of contributing so much as chemists to the solutions of the great problems that the war presents. He said:

"I need hardly refer to the possibilities, nay, the actual achievements, in the operations of the war. Much is being done by the members of your society, the best of it quickly and without being heralded in the press, so that it will probably not be till the war is over that the public learns of the actual accomplishments of American chemists in the field that I have indicated. When the story is told it will add lustre to the name of American science.

"Every patriotic citizen to-day, whatever his calling, should be preaching and practising the doctrine of economy—the absolute necessity for avoiding all needless expenditure, which is only another word for work.

"This must be done everywhere, in our households, in our business, in our Government, and few can render so much service in saving work as the chemist."

The report of the war conference on Tuesday, Sept. 11, was given in our last issue, excepting the address of Dr. M. T. Bogert, Chairman of the Chemistry Committee of the National Research Council. A full abstract of Dr. Bogert's address follows:

Work of the Chemistry Committee of the National Research Council

BY DR. M. T. BOGERT, CHAIRMAN

American chemistry must justify itself, and show its ability to cope with the chemistry of other warring nations. What we have done to secure chemistry in this country may be illustrated by citing three organizations which we have at the present time, who are cooperating very effectively.

1. The Naval Consulting Board organized by the Secretary of the Navy, and concerning itself with problems which affect the Navy.

2. The work of the Committee on Chemicals of the National Defense Council described by Dr. Nichols.*

3. The third chemical committee is the National Research Council. This council was called into being before the outbreak of the war at the request of the President of the United States, and was organized by the National Academy of Science. It is the official adviser of the Government. It was very fortunate that this was done, because at the outbreak of the war we already had the necessary machinery to undertake the numerous problems which came to us.

The first business of the chemistry committee was the appointment of the necessary subcommittees.

In the second place, the census of chemists conducted by Dr. Parsons and the Bureau of Mines carried, as you are aware, a slip for research chemists—those who were interested in research. These research slips were all detached at the Bureau of Mines and transferred to our office, where they in turn have all been closely read, indexed and cross-indexed, and through the chairman of the sub-committee, we have now gotten out an alphabetical list of the chemists who are interested, and experienced in particular lines. That alone is a tremendous thing, because it puts in the hands of the sub-committees a list of the names of the men in the country who are interested and eager to attack problems which at the present time are unsolved. Further, this chemistry committee has co-operated in placing drafted chemists in service where they will be of benefit to the country. They have had to study 300 different problems and report through different departments of the Government concerning these different problems. Perhaps the chief function of the chemistry committee is that of endeavoring to act as a central clearing house. If that can be realized, it will be a splendid accomplishment for the country as a whole. If we have one centralized agency of this kind doing not only Government but other research work, some of the developments and overlappings that we have allowed, may be avoided. In connection with that function, a Bureau of Information could be established. Every day we have a great many questions of all kinds to answer, which can be answered by accumulated information.

We do not feel at all discouraged that all the suggestions which come in from the outside are not all of great value. The experience in France and England has been that one in 300,000 of the suggestions sent in, have some real value. Another function of the committee is that of raising funds to carry on its work, and I might add that one who has made this work possible is one that is benefactor of this institution also, Charles Hayden, of Hayden, Stone & Co., and he has been very generous in carrying out this work.

Another direction in which useful service is rendered is that of bringing distinguished chemists from France.

We have sent over to France and to England representative scientists who have studied the situation there at the front in the warring countries, and have brought back first hand information in order that we may direct our lines of work, and have the benefit of what was being done, and this has been of the greatest value on this side. Three other chemists are about to leave this country on similar missions, and we hope in this way to keep in close personal touch with what is going on on the other side. As a result of our experience at the present time, we believe that chemists are needed for the following:

1. Teaching is fundamental. We must have chemists to continue the teaching and training of new chemists—a recruiting station for chemists.

2. Chemists are needed for the control and direction of industrial operations of all countries—munitions, poison gases, gas masks, metal, leather, oil, alloys, drug, food and dye stuffs.

3. Inspection and analysis of munitions, supplies of all kinds, etc. This is a direction in which engineering and analytical laboratories of our educational and research laboratories throughout the country can help and are already helping, and will be called upon for

*See our last issue.

services to supplement agencies of the Government now had for that purpose.

4. Development of new plans and processes made necessary either by increased demand or by the cutting off of former sources—the potash industry, for example, and an example of a wholly new industry is that of poison gases.

5. Small scale manufacturing operations, in our educational research institutions, synthetic drugs and special reagents without which no research work can go on, and which are produced in such small amounts that they are of practically no interest to the manufacturer. This is very important for the carrying on of the war, and for the safety of the country. In this direction the universities and research laboratories are aiding, and will aid us.

6. For research, and to aid the Government in securing defense for our country, and to protect our soldiers, and also increase our power.

7. As advisers to the Government, bringing to it in the first place, the best knowledge and best qualified men of the country to attack problems and then initiate what research work is called for. We should not fall into the habit of assuming that because we cannot answer a research problem at once, therefore we should say that we are not interested in it. The warring nations will tell you that if they had only initiated certain research work at the outset of the war, the answer to some of the problems might be available, and would be determining factors, so we should initiate research work, although it may be some little time before the answer can be obtained. Another important function of our sub-committees is acting as advisers to the Government, and assisting them, and they are being of the greatest service.

8. For our Government laboratories to supplement the present forces when necessary on account of the demand put upon them, or to fill the places made vacant by men drafted into the army and into industries.

These are some of the directions in which chemists are urgently needed. As far as the needs are concerned, the first thing for the proper conduct of the work is the matter of funds. There must be an adequate appropriation in order that the work may be carried on, as without funds they cannot carry forward the work.

A better recognition is needed on the part of the Government of what this organization can accomplish. The Government should get into the habit of turning to this corps of chemists through the Committee on Chemicals of the National Defense Council, and the Chemistry Committee of the National Research Council for aid, which both are ready and prepared to supply.

Another need of the situation has to do with our industrial chemists and those who are drafted and exempted. I believe it would help the situation very much if the chemists drafted and then exempted were given some insignia to indicate that fact that they were exempted on account of their need in the industry, and that in that industrial army they would render just as valuable and important service to the country as if they were serving in the trenches. In France they wear an insignia on their arm, and something like that would help here. France also has an organization of industrial workers, and their work must be done very carefully. If they make any mistake, the first thing that happens to them is that they are sent to the front. On the other hand, if they are guilty of treason, they are tried before court martial and shot.

As far as the problems are concerned which confront this committee, let me say at the outset that we have a great many more volunteers than we have problems, and that you must not be disappointed if in spite of your willingness, you have been unable as yet to secure a satisfactory reply from the Chemistry Committee. Do not overlook the fact that the Government has already an existing agency for the study of a great many of these problems. We are not in any way trying to supersede them, but we are trying to supplement their work in every way that we can, and the reason why it has not been possible to transmit problems, is that there are more volunteers than problems. This condition will rapidly disappear.

An incident showing our co-operation with Government agencies and the character of some of these problems I will endeavor to indicate by one or two examples. As you will understand, many of the most interesting of these problems are of a highly confidential character, and cannot be stated.

In the first place, take such a problem as hydrogen. The question of hydrogen generation is a matter of considerable interest to our aviators. They must have the best possible method of producing an adequate supply of real hydrogen, and it is necessary also to have an outfit which can be used for this, and also on shipboard. That is a problem which involves the standardization of materials which are to be used for hydrogen. It involves also incidentally the question of ability to protect the hydrogen. An important problem in the submarine situation is the detection of hydrogen. It was necessary to devise an automatic detector. Co-operation with the Bureau of Standards and the Department of Chemistry of the University of California has resulted in the production of two detectors which are entirely satisfactory. This has been brought about by Dr. Bray and Dr. Lewis formerly of Massachusetts Institute of Technology and now at the University of California.

The submarine question has brought out a number of problems, such as the production of suitable noncorrosive metals or alloys for submarine guns and torpedoes, and equipment to be used on submarines. In the case of balloons, other questions which have come up relate to the fabric to be used. In the case of airplanes, the fabric to be used, and also the proper kind of "dope" to be used on the wings, and there is also the question of the right kind of glue to be used in the manufacture of propeller blades, etc. In airplane service, one of the most important questions is the question of a suitable fuel. This is of the utmost importance. If we are going to build an enormous fleet, we must see that they are provided with the best possible fuel, in order that the airplane may rise to a sufficient height to make an attack upon the opponent. This is very important. If an airplane is provided with a fuel which will not permit it to rise to the same height as its opponent, it is a distinct disadvantage.

In connection with the needs of our war, proper paints for our war vessels have been studied by various committees, and at the present time they are working in conjunction with the Bureau of Standards on

specifications for twenty-five different types of paint and varnish.

The fertilizer situation is being attacked from a number of points. The potash and nitrate situation and other problems have been studied by Dr. Wheeler, and it has been found that such a question as top dressing on winter wheat in spring means a difference of 200,000,000 bushels in the supply.

Such questions as the production of the necessary textile and dyestuffs have also been studied.

The question of synthetic drugs is also very important, and is now being studied. A large proportion of these drugs was derived from Germany, and it has been necessary for us to prepare these ourselves or go without them, and that means not only the question of patent situation which we are called upon to handle, but means the question of working out the details necessary for the successful manufacture.

The question of explosives in all aspects is now being studied by Dr. Comey, chief chemist of the Du Pont Co., not only in regard to adequacy of supply, of raw materials, but also the possibility of using other explosives, in order that we may be prepared in every sense.

The most important of all the fields in which we have been working is that of gas. At the time of the first gas attack, which was April 15, 1915, a chlorine gas attack was made. The result of that attack was such that the British General sent back word that if some protection was not provided in comparatively few days, they would have to give up that entire section of the line. If there had been no chemists, it would have been a very serious situation. This also illustrates the necessity of speed to which they were put. Inside of four days 3,000,000 masks were provided for the British Army. At the present time we have a great variety of gas protections. Some of the most poisonous gases are now being used at the front.

Presidential Address

Dr. Julius Stieglitz, of the University of Chicago, presented his presidential address on Wednesday evening, Sept. 12, in Huntington Hall in the old Rogers Building of the Massachusetts Institute of Technology in Boston. He said that chemistry is all that, thus far, has saved Germany from defeat. After Joffre on the Marne had killed her hopes for a swift, crushing victory through the violation of Belgium, it taught her that she must face a long struggle, in which, cut off from the world's supplies, she must make shift with what her own territories could yield and her chemists could produce.

"In the wonderful organization of power in France and England in the midst of war the French and English chemists have stepped in and brought their supplies of munitions of every variety, of remedies, of their own weapons of defense and offensive poison gas and liquid fire warfare, up to the need of meeting now on more than equal terms an enemy prepared years in advance.

"And in our country too, chemists have stood the ordeal of an unprecedented time. I have in mind our splendid achievement of having solved in these three years of warfare such tremendous problems which three years have brought to us as were involved in the speeding up of the production of thousands of tons of fundamental chemical products needed by our allies and now for our own purposes, steel and iron alloys of every variety of toughness, hardness and elasticity, purified copper by the millions of pounds, aluminium for airships and motor cars, abrasives on which the trueness of every great and every small gun depends, sulphuric acid and alcohol for the preparation of explosives, foods, oils and scores of essential products prepared on a scale never before seen."

Professor Stieglitz mentioned the growth of the society from somewhat over 8000 members before the war to nearly 10,500.

He also said: "It has been publicly encouraged in Germany—I am quoting from an excellent article by our friend, Dr. Baekeland—that German dye manufacturers after the war should allow only a limited and conditional quantity of dyes to go to foreign countries, including the United States, in order to give her home industries a great lead in recovering the commerce of the world in textiles.

"Even if this suggestion should not be put in effect, for Germany has more to lose than to gain by a policy of trade war after the reestablishment of peace, we may be sure that her own manufacturers will get the best of her supplies and every possible advantage. Our textile manufacturers and many other branches of industry will be at the mercy of competitors, assisted by Government direction, unless we have a declaration of chemical independence in this country."

He said that manufacturers should treat research chemists more fairly by sharing more equitably the profits resulting from their discoveries instead of exploiting them. The wiser policy has been largely responsible for the German leadership in chemical manufacturing.

He advocated a definite national policy looking toward the establishment of independence of chemical supplies. One of the most important measures necessary to this end he believed to be the fixing of protective duties.

"Much more than a question of coloring materials is concerned in a conscious policy to have our dye industries established on a permanent basis. It has often been emphasized that the manufacture of dyes is so closely related to the preparation of explosives that a flourishing dye industry in times of peace means ample facilities for explosives in times of war.

"No American would care to contemplate what our condition would be in the matter of large-scale production of explosives if we had become engaged in a struggle with a first-class power without the benefit, without the great expansion in our dye and explosive factories, which our commerce with England and France brought about after 1914. When peace comes, let no American forget this lesson. One way of insuring ourselves against a lack of facilities for a sudden expansion in the production of explosives is to keep capital invested in dye factories."

He spoke of the progress of United States universities and colleges in chemistry and urged that they "be kept not only prolific as to the output of men—the vast expansion in laboratories and attendance bear witness to quantity being insured—but that they also be maintained on such a high level of scientific quality that the product going forth will consist of the very best type of men."

Metallurgical Symposium

The metallurgical symposium held Thursday morning was the third held by the Society. Prof. W. A. Whitaker, of the University of Kansas, presided. The question was brought up as to the advisability of establishing a metallurgical division of the American Chemical Society to take up the chemical problems of metallurgy. Several of the members expressed their views on the subject, and it seemed to be the consensus of opinion that the society ought to do all in its power to foster metallurgical chemistry, that is, the theoretical side of metallurgy as distinguished from the purely practical side of metallurgy. No recommendations were adopted but the question will probably be taken up by the Council at a later date.

An interesting paper on "Stellite as a Substitute for Platinum" was read by Elwood Haynes, of the Haynes Stellite Co., Kokomo, Ind. The product is well known but its use as a substitute for platinum is quite an innovation. Mr. Haynes said it could be used in jewelry and was a very good substitute. It is limited as a platinum substitute for chemical purposes on account of its being corroded by several acids (not by nitric). It has about the same melting point as platinum. In order to show the wide range of its usefulness, Mr. Haynes passed around some spoons, knives, a razor, hatchet and several other samples which appeared to be indeed very good-looking articles. It is hoped to publish Mr. Haynes' paper in a later issue.

A paper on "The Effect of Annealing on the Electrical Resistance of Hardened Carbon Steels," by I. P. Parkhurst, was read by H. E. Howe. The general conclusions drawn by Mr. Parkhurst from his experimental work was that the total change of resistance increases with the carbon content.

Dr. J. W. Richards had prepared a very interesting paper on "Physico-Chemical Data Needed by Metallurgists." Dr. Richards was unable to be present and his paper was read by H. E. Howe. The paper discussed very fully the woefully insufficient thermochemical data available for metallurgists. This is true of both low and high temperatures. High temperature data are, however, even scarcer than low temperature data. He outlined a few subjects in which data were badly needed, mentioning the combinations of metallic oxides with silica, sulphur and with each other; the heats of formation of arsenides, arsenates, borates, manganates, aluminates, etc., and a large number of others. There is enough data needed to keep a dozen thermochemical laboratories busy for ten years. For temperatures above the ordinary our thermochemical data are not exact. For instance, in distilling zinc, the energy involved is far different than indicated by the equation $ZnO + C = Zn + CO$ when the figures for solid zinc are used as in this case zinc vapor is formed. Other data badly needed are the specific heats of all substances, the latent heat of fusion, latent heat of vaporization, specific heat in the gaseous state and liquid state. The latent heat of fusion is needed on steel, brass and bronze, and the latent heat of vaporization has been experimentally determined for only 3 metals and 6 metallic compounds. Vapor tension curves are badly needed. We only know the specific heat of brass and bronze from 100 deg. to 0 deg. The metallurgists are looking to the physical chemists for these data and laboratories should look into this field.

A paper on "Sulphur Dioxide in Metallurgy," by E. R. Weidlein of Mellon Institute, Pittsburgh, Pa., was read by G. C. Stone. The paper described work in an experimental plant at Thompson, Nevada, on the precipitation of leached copper by sulphur dioxide. The process is described in U. S. Patent 1,201,899, Oct. 17, 1916, which was abstracted very fully in our issue of Feb. 15, 1917, page 227. The process is applicable to low-grade sulphide and oxidized copper ores. The precipitated copper contains only oxygen as an impurity and runs over 99 per cent pure. An important feature is that the precipitation is continuous. Mr. George D. Van Arsdale of Phelps, Dodge & Co., said he would be interested to know the costs of working the process and was also interested in knowing that the precipitation had been made continuous.

A paper on "The Importance of Flotation in Copper Metallurgy," by E. P. Mathewson of the British-America Nickel Company, of Canada, was read by Dr. Dorsey A. Lyon of the U. S. Bureau of Mines. The paper reviewed the important developments during the last few years.

The "Theory of Froth" was discussed by Dr. W. D. Bancroft in his usual interesting manner. He said that froth may be defined as a mass of globules with liquid walls. In order to get a froth a surface film must be produced different from that of the body of the liquid. This involves a change in the surface tension, either greater or less, of the film from the mass of the liquid. If something can be put in which gives a more viscous film the froth will be more stable. Permanency of foam is a question of viscosity. If you fill up the film with a solid the froth will be more viscous, you can stabilize kerosene, pine oil, etc., with white lead.

Most oil mixtures used in flotation do not give stiff froths by themselves but the metallic sulphides make the froth permanent.

Dr. Charles H. Herty in the discussion asked whether oleo resin added to pine oil would help. Dr. Bancroft said that if it did not cut down the stiffening of the froth by the sulphides, it would be all right. Mr. O. C. Ralston of the Salt Lake City Station of the Bureau of Mines said that the important question was how to get selective action in certain sulphides, *i.e.*, how to make one mineral go into the froth and keep others out.

"Chemicals Used in Ore Flotation," was the subject of a paper by O. C. Ralston and L. D. Yundt. The paper was read by Mr. Ralston. It will be published in full in a later issue.

A paper on the "Action of Cadmium Salts on Lead and Zinc Sulphides," by M. H. Thornberry, was not read, as Mr. Thornberry was not present. Professor Whitaker said the substance of the paper was that cadmium salts greatly hindered the flotation of lead sulphide.

A paper on "Flotation of Zinc Sulphide Tailings," by W. A. Whitaker, S. F. Farley, and H. P. Evans, was read by Professor Whitaker. It is hoped to publish this in full in a later issue. Professor Whitaker said from the results of many tests they found that light oils such as pine gave high grade concentrates but a lower extraction than heavier oils. The heavier oils, however, gave lower grade concentrates. By properly mixing the light and heavy oils the best economical procedure could be obtained.

Third National Exposition of Chemical Industries

Comprehensive Report of Important Addresses and Meetings of Technical Societies*

Showing a continuous growth at the rate of 100 per cent for each year of its existence, the National Exposition of Chemical Industries was held for the third time in Grand Central Palace, New York, from Sept. 24 to 30, inclusive. With exhibits well in place at the opening hour, the management and exhibitors were fully prepared for the large attendance which marked the opening of the doors.

The opening exercises at 2 o'clock in the afternoon were marked by keynote addresses from the chairman of the Exposition Advisory Committee, and the presidents of the three great chemical associations of the United States—American Chemical Society, American Electrochemical Society and American Institute of Chemical Engineers. These addresses, short and to the point, are given in full below. Accompanying is a view of the distinguished speakers and managers of the exposition who occupied the platform at the opening session, Mr. Charles F. Roth, presiding.

A feature of the exposition which appealed strongly to the popular mind and held interest also for technical and engineering visitors, was the exhibition of moving pictures illustrating power development and the operations in a variety of industries.

These pictures had an educational value of high order and served to stimulate general interest in chemical industry in the United States.

*See page 420 for descriptions of exhibits.

The Battle of the American Chemical Industries

By Chas. H. Herty†

The battle for national self-containedness in that portion of the line held by the American chemist is progressing favorably. It is not yet won, but many heights have been conquered, many formidable streams crossed, and the open plains of full national service are almost in sight.

This exposition, increasing in magnitude each year by 100 per cent of its original size, constitutes the bulletin by which the nation is informed of the progress made.

SPEAKERS AT THE OPENING SESSION

Left to right: G. W. Thompson, Pres. American Institute of Chemical Engineers; Julius Stieglitz, Pres. American Chemical Society; Messrs. F. W. Payne and C. F. Roth, managers of the Exposition; Colin G. Fink, Pres. American Electrochemical Society; Charles H. Herty, Chairman Exposition Advisory Board.

In the center, the advance up the steep slopes of "capitalization" has been marked. In 1915 there was added to the chemical industries $65,565,000; in 1916, $99,244,000; and in 1917, up to Sept. 1, $65,861,000, a total gain of $230,670,000.

On the extreme right the forces of "Empiricism" have steadily yielded ground to the advances of our research chemists. More and more called upon for utmost effort, they have never failed to respond.

On the left flank a steadily increasing force of the ablest American chemists is being gathered to capture the hill of "Obsoletism of Army Equipment," and is providing the great armies we are now raising with

†Chairman, Advisory Board of the Chemical Exposition.

the most efficient forms of modern chemical means for both offensive and defensive warfare.

On the right center the terrain of "Congressional Apathy" has been partly won, as typified by favorable protective legislation for our dyestuff industry and by the guarding of the all-important electro-chemical industries at Niagara Falls from power shortage due to lapsing legislation.

On the left center the quagmire plains of "Public Indifference" have been largely dried and made passable through the clearing skies of a sympathetic daily press, which has constantly emphasized the value to the independence of the nation of a full-rounded chemical industry.

Finally, the counter attacks of subtle propaganda against the ability of American chemists and the worthiness of our products, such as American dyestuffs, have ingloriously failed.

The optimism engendered by such splendid progress will prove, however, a curse indeed if it leads us to overlook two features of the present situation.

In the first place, in order to man the present lines of this battle of the chemical industries we have already drawn heavily upon our reserves in the universities throughout the country. Many professors, advanced students, and even only partly trained students, have been called into the industries. This, together with the losses by enlistment, has created a serious shortage of chemists, whose replacement through all favoring means should be a constant charge upon the liberality of the leaders of our chemical industry and the farsightedness of those vested with the powers of national administration.

In the second place, this army has its camp followers, men who, under the guise of chemistry, seek to enlist capital in developments bearing all the earmarks of get-rich-quick schemes, the disastrous outworking of which may perhaps shake that confidence between capital and chemists which should grow daily stronger if this battle is to be fully won. And it must be won. Only patriotic motives underlie that conviction.

It is the nation's service to which we are called, and to that service the good faith and untiring zeal of the American chemist is pledged.

* * * *

American Chemical Industry and the American Chemical Society

By Julius Stieglitz*

"Every cloud has its silver lining," and even the great black cloud of war which has been oppressing the world these three years has been penetrated here and there by bright rays of good accomplished. One of these brighter effects of the disaster, as far as this country is concerned, has been the influence of the war on our chemical industries. Facing the necessity not only of very greatly expanding their output, but also of developing many new products and of making older products of a far higher grade in quality than ever before, our American industries, as evidenced by the three expositions held in this place, have met and conquered one great problem after the other. We may confidently expect, and indeed we must insist, that out of this period of forced effort we shall emerge independent of all foreign nations in regard to our ability to supply the basic chemical needs of our country, not only in quantity but also in quality. As a single instance of the progress these years have witnessed in a field we must continue to hold after the war, let me recall the dismay of our universities—and I am sure also of our industrial laboratories—when, early in 1915, we saw the supplies of Jena glass and of other finer glass cut off. Yet to-day we are manufacturing in the United States glassware fully as good as, if not indeed superior to, the German brands we thought we never could do without. When the war is over, no matter how fierce trade competition may be, we must see to it that our new industries survive, that we do not relapse into our old dependence on European sources for almost every article in which quality, highest quality, is essential! In the heat of effort of these years only the most urgent and immediate of our needs have been met; some of these results still depend for their stability upon war conditions, they are still too liable to collapse when the world returns to its normal life and trade is free once more. In this situation, fraught with magnificent possibilities for much greater chemical achievements, but also with great dangers for the permanency of some of the American chemical industries, the American Chemical Society, for which I am speaking, sees its opportunity of being of new and still greater service to the country. Including in its membership of more than 10,000 the great majority of leading technical chemists, as well as practically all the foremost men of the chemistry staffs of our universities and colleges, the society is in a position to render service in any branch of chemistry, service that will be expert and at the same time judicial and unbiased in its spirit. Thus the society, influenced by the conviction that our national welfare demands independence in dye manufacturing, was active in aiding the movement to secure a much needed measure of protection by duties on dyes. They, at the invitation of the chairman of the United States Tariff Commission, the American Chemical Society, through its advisory committee, a few months ago, recommended the name of an expert on chemical schedules, Dr. Grinnell Jones, who is now working with the commission on the task of placing the tariff on a scientific, non-political basis. The society recently urged upon the Secretary of Commerce that standard chemicals and reagents are as essential for successful work, for the saving of wasted effort, in chemical industries, as are standardized weights, measures and gages in other industries. With the approval of Secretary Redfield, the Bureau of Standards, and with the co-operation of a committee of the American Chemical Society, has now started this important work. Then our appeal in Kansas City to the women of the country to refrain from the purchase or acceptance of platinum jewelry had its immediate effect; within a few days thereafter the jewelers' representatives in conference with the Secretary of Commerce agreed not to use the precious metal for heavy articles, thus making a larger proportion of it available for the industries. According to the latest information that has come to me, the price of platinum has at last begun to recede somewhat, instead of continuing the steady rise which its extravagant use in jewelry brought about, and which put a burden equivalent to a duty of several hundred per cent on a vital necessity of our scientific and industrial laboratories. I have the fullest confidence that if the situ-

*President, American Chemical Society.

ation should remain intolerable we shall have the support of the government in taking much more stringent measures to protect chemical industries and scientific work, so vital to our nation's life, against a use that is, after all, a matter of a mere luxury. Further, at the instance of the American Chemical Society, and in co-operation with a committee of the society, the Bureau of Foreign and Domestic Commerce has started the compilation of as complete information as it can secure for the guidance of our industries in regard to the chemical needs of manufacturers, the sources of supply of crude and finished products, and the relation of the various products to one another and to specific industries. Thanks to the efforts of the able editor of our industrial journal, Dr. Herty, a large fund has been raised to make possible this co-operation of the society with the government in this important work, and if the chairman of our committee, Dr. B. C. Hesse, has his strenuous way the work will be a model of thoroughness and usefulness.

I have mentioned these instances of the activities of the American Chemical Society in order to emphasize that the society would cordially welcome any appeals made to it by industries needing support of one kind or another. We are now organized for quick and effective action in matters of legislation and policy through the President's Advisory Committee, in matters of research through our affiliation with the National Research Council, all of whose active members in chemical fields are also active members of our society. If such appeals or suggestions are received, they will receive prompt and earnest consideration, and, if necessary, they will be looked into by committees of experts, not only with that fair judicial spirit which science develops in its devotees, but also with that sympathy and consideration which the service of our country instils into her sons. Final action will then follow, with that fearlessness and energy which a good cause always warrants, and which we trust will always be truly in the interest of the American Chemical Industry.

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The Electrochemical Industries

By Colin G. Fink*

It was certainly a very propitious moment when, three years ago, Mr. Roth and Mr. Nagelvoort suggested and planned the first chemical exposition. The American Electrochemical Society heartily welcomed the idea, and felt fully confident that the enterprise would be popular and successful. An undertaking which is based on the promotion of the common welfare, an undertaking that affects the progress and prosperity not of a few individuals but of every member of the country; an undertaking that serves to teach and demonstrate in a very striking and lasting manner the diverse applications and activities of the most fundamental of all national industries—an undertaking of this kind *cannot* fail; it *must* succeed. At the first exposition the exhibits were confined to one floor; in the second year the booths extended over two floors; and in this third year practically every square inch is occupied. Very soon Mr. Payne will have to build a bigger palace.

Never before in the history of electrochemistry has the vast importance of the various electrochemical products been so forcibly brought to the attention of our government and of our people as in the present year of the great war. Take from this country its electrochemical industry, with its numerous and diversified manufactures, and the martial strength of our country is hopelessly crippled. Think of the hundreds of machine shops that are utterly dependent on the electrochemical abrasives, carborundum and alundum; think of the thousands of rifles and guns turned out every month with the aid of high-speed steel made from electric ferro-alloys; think of the millions of pounds of electrolytic copper that are absolutely essential for our electrical apparatus. There is the airplane, whose light, strong stays are made from the electrochemical metals, aluminum and magnesium; there is liquid chlorine, a product of the electrolytic cell, and the basis of the Carrel-Dakin method of treating the wounds of our heroes; there is electrolytic hydrogen, used in all of our scout and observation balloons, and there are the numberless electric alloys entering into the composition of nearly every item of the government's vast military equipment.

An interesting feature of the electrochemical industry is its American origin and its present international scope, international in so far as the industry is not restricted or confined to one or two countries or localities. Take, for example, the calcium carbide industry; this was founded by an American, Thomas Willson; within a brief generation it has grown, in leaps and bounds. To-day there are large carbide factories in almost every civilized country of the world. Compare with this the sulphur industry, confined to the United States and Italy; or the petroleum industry, confined to the United States and Russia. The natural saltpeter industry is confined to Chile, but the electrochemical saltpeter industry, founded by Bradley and Lovejoy at Niagara Falls, has spread to every important civilized center.

Wherever low-priced water power or low-priced fuel is available in generous and steady amounts, there electrochemical industries have been and will be established. Our country has been foremost in the electrochemical industry ever since its inception, due to American genius on the one hand and to our vast natural resources on the other. May we continue to lead the world in the supply of the many electrochemical products: pure metals and alloys for the arts, gases for cutting and welding, chlorine and peroxides for our hospitals, chlorates and acetone for munitions, nitrates for the farm and defense, abrasives, electrodes, solvents and lubricants. May we continue to excel in the products of the electric furnace and the electrolytic cell.

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The Work of the Chemical Engineer

By George W. Thompson*

This exposition demonstrates the greatness of the progress which chemical industry in all its branches has made in the United States in recent years. When an industry is small its requirements are small. As it becomes larger its requirements become larger. The manufacture of chemical products on a small scale in a laboratory is a relatively simple operation, but when this manufacture is conducted on a large scale, involving the investment of considerable capital, then the prob-

*President, American Electrochemical Society.

*President, American Institute of Chemical Engineers.

lem is much more complicated and much more difficult to solve.

On this large scale the chemical engineer is the important factor; not so much perhaps in the development of the processes as he is in the devising of machinery that will carry out these processes. Most chemical processes have been developed upon a small scale in the laboratory. All of the reactions have been worked out in this way. When the process has become so developed it is studied for the purpose of putting it into operation on a scale that will produce a relatively large quantity of chemical product. To do this, the knowledge of the mechanical engineer is needed, but in addition to the knowledge of the mechanical engineer there must be supplied a knowledge of the resistance of materials to chemical reaction, which is provided primarily by the chemical engineer. This is particularly well illustrated in this exposition, where apparatus for a great variety of uses in chemical manufacturing are displayed. In practically every chemical manufacturing operation a great part of the study leading up to its becoming a commercial success has been the finding of materials from which the apparatus could be made in which to conduct the chemical reactions involved.

On small-scale manufacture, platinum, glass and porcelain have, in most cases, been satisfactory. The use of these materials, however, for large-scale operations has been prohibited by the high cost of the materials or their fragility. It has been found, however, that by the selection of certain alloys of iron, chemical apparatus can be manufactured in which certain chemicals have been made to react upon each other without reacting upon the apparatus. Such reactions could be conducted in porcelain or stoneware were it not for the difficulty of making large porcelain or stoneware vessels that would not be destroyed by the heat of reaction, or necessary to reaction, involved in the process. The discovery that silica could be made into chemical ware, and that such ware had a very low coefficient of expansion, has made possible the use of such ware for many operations requiring the application of heat to liquids. With the demand made upon it, the manufacture of chemical stoneware of intricate shape and design has progressed to a remarkable degree, so that within the limits of its use there is practically nothing that can be asked for in this class of apparatus.

Our early knowledge of chemistry had to do almost exclusively with irreversible reactions. Modern chemistry has largely to do with the reversible reaction, a reaction which takes place according to fixed rule, as determined by the temperature and pressure under which and at which the chemical reaction takes place. Every chemical manufacturer desires to get as high a yield of product as possible from every chemical reaction employed. To do this he must, in many cases, control the temperature or the pressure, or both, as the case may be, within certain relatively narrow limits. The needs of chemical industries in this respect have been so great that accurate instruments for the measuring of temperature and pressure and for their automatic control have become imperative needs. At this exposition there are on exhibition numerous pieces of apparatus designed particularly for the purpose of controling temperature, and to some extent pressure.

Every chemical industry depends to a certain extent upon its operation being carried out economically. This economy must extend to all departments. One of the most important departments is that connected with the production of power. The importance of obtaining the highest efficiency possible from a steam boiler is self-evident, and this can only be done by having as complete as possible combustion of the fuel used. There is one sure way of doing this, and that is by having continuous readings made of the carbonic acid gas present in the stack gases. It would be too expensive to employ a chemist to frequently take samples of these gases and analyze them, but with modern CO_2 recording instruments this is done automatically, with great economy in steam production. Such apparatus has also been available in cases where the CO_2 is used in chemical processes. By a greater concentration of CO_2 the handling of excessive quantities of useless gases is avoided.

The designing of apparatus in which to conduct chemical reactions, with the result that desirable chemical compounds are produced, is also peculiarly the work of the chemical engineer. The reactions themselves, as indicated above, have become known as the result of laboratory work, but to design apparatus so that these reactions will go on with the greatest practicable rapidity, and to the highest degree of efficiency, requires a man peculiarly trained in some way to apply on a large scale the law of mass action and the other laws of physical chemistry. The removal of an undesirable component rapidly and efficiently, thereby taking away the slowing-up effect due to its partial pressure, is often a difficult problem; but with the modern methods illustrated in this exhibition the problem becomes easier. Here we find apparatus designed for particular purposes in which operations can be carried on in a vacuum, or with the assistance of efficient stirring appliances, or in the utilization of centrifugal force.

Much of our progress has been due to the utilization of electrical energy, and in this exposition are shown the products of the electrothermal reactions, also electrolitically prepared or refined metals and chemical products. Here also are seen illustrations of the removal of suspended matter from gases by terminals highly charged with static electricity, and means for separating minerals electrostatically or by the electromagnet.

These are only a few of the many illustrations which could be offered of what is seen in this exposition, showing the mechanical genius of the American manufacturer and his ability to convert chemical reactions into profitable business enterprises. I believe it would be proper to extol this ability. The American cannot expect to excel in everything, and if he excels in this particular line it is a sufficient "Crown of Glory." That the manufacturer of chemical products has not accomplished everything that could be desired has not been due to his lack of ability or energy, but has been due to his inability to obtain those raw materials which nature has furnished to other countries more generously than she has to us.

With the progress of chemical industry the kinds and varieties of chemical products made are increasing from day to day. We see evidences of improvement in quality and the probable reduction in price as the competitive conditions become more nearly normal.

The Institute of Chemical Engineers is glad to join in this exposition in an advisory capacity, or in any other way it can be useful, because it believes that the

future commercial success of our country depends upon the continuance of the present efforts, looking in the direction of the expansion of chemical production and the manufacture of chemical products.

Tuesday Meetings

On Tuesday afternoon ALEXANDER SILVERMAN of the University of Pittsburgh gave an illustrated lecture on "Glass Manufacture," and showed many forms of blown, molded and pressed glass.

On Tuesday evening a special session was held which was presided over by Dr. B. C. HESSE of the General Chemical Company. Dr. Hesse opened the meeting with a splendid address, which we publish here practically in full.

INTRODUCTORY ADDRESS OF DR. B. C. HESSE

"The program of this evening is admirably adapted to illustrate and emphasize the relations that may and do exist between abstract scientific knowledge on the one hand and the realities of every-day life on the other. Not that abstract scientific chemical knowledge is alone so concerned, for there are many others that will occur to you and I need merely remind you of Faraday's electromagnetic theory of light of 1845 together with the purely mathematical investigations of Maxwell in 1864 on the one side, and of the Hertzian waves of 1888 and Marconi's wireless telegraph in 1896 on the other side.

"Some sixty years ago an English youth still in his 'teens, pursuing an abstract scientific problem, encountered an unexpected and astounding result and upon this he built an industry, which has since developed into gigantic proportions, but whose enormous influence and importance were not convincingly impressed upon the general public until the present world-war. I refer, of course, to the present-day coal for chemical industry in all its ramifications into every-day life all over the world. This, however, was by no means the only case in which the peoples of the world were rudely awakened. Of the many results of that awakening two will be discussed to-night.

"Suddenly, and even violently, confronted with the actual reality of our dependence, both direct and indirect, upon foreign countries for a great many things in common and widespread use, the general public became most insistent in its demand; first, to know why such a condition had been permitted to grow up, and second, to have that condition permanently abolished at the earliest moment.

"Analysis of the situation discloses that in the first of these two demands there were at least two general classes, the first class comprising those cases whose importance was recognized and for which all or substantially all needed raw and similar materials for domestic supplies, but whose utilization in such domestic manufactures was discouraged by domestic consumers of such manufactures, or by our Federal legislators, or by both combined; in the second class were those cases whose real and interlocking importance did not sufficiently impress themselves.

"A first approach to an answer to the public demand as to why this condition was permitted is as to how it grew up; it grew up through our own acts of omission, because as we built up our industries we did not, as a nation, seriously, systematically and persistently study what effect sudden deprivation of the non-domestic materials employed in these industries would have on our nation as a whole, and then act to prevent or minimize such effects; that applies to our citizens, to our Federal officials, and to our Federal legislators. Just why this condition existed is not easy of explanation, but, no doubt, a large contributing factor was the general disbelief in a war of present-day proportions and effects.

"If I am correct in my conclusion that this dependence grew out of this general disbelief in such a war then I am probably correct in deducing therefrom that the second public demand, permanently and immediately to abolish that dependence, is based upon a public belief in a possible recurrence of such a war and public determination not again to be so disadvantaged in such an event.

"In that view it becomes necessary constantly to determine what things not made in this country must be made here; then to determine the best way of making them; next to decide what measures, Federal or otherwise, are needed to make them permanent, and, finally, to carry out the necessary program.

"To help solve the first two sections of this program, namely, what to make and how, the National Research Council was created; to aid in solving a part of the third section of this program the United States Tariff Commission was created by act of Congress in September, 1916. For products of and for our chemical industry the Chemistry Committee of the National Research Council has taken over the burden, and the Tariff Commission has provided for expert chemical direction and execution in its technical staff. The National Research Council is largely a volunteer offering of our citizens; the Tariff Commission is the contribution of our Government. Since our citizens and our Government have so determinedly and so sagaciously joined forces we may confidently look forward to lasting results of untold value to our country; it is a sure way to make a democracy lastingly more efficient than an autocracy.

"While the immediate work of the National Research Council is necessarily directed towards helping to remove present defects in our means of national defense, yet it ultimately will be engaged in helping to determine the best course of development of the whole country and the best way to effect it. We may, therefore, expect that the influence of the National Research Council will ultimately penetrate and benefit every branch and division of our national activities. However, its work cannot last if the country does not continue to develop men and women who are capable of research work and, therefore, a collateral field of influence of the National Research Council will be to assist in keeping our technical schools, universities and colleges at the very forefront of educational efficiency. Finally, we may confidently expect that the National Research Council will be the very efficient 'eyes of the nation' by keeping close watch on all scientific and technical progress all over the world, discerning our own national advantages in developing selected portions for ourselves and in co-ordinating our efforts for such national development.

"Among the Federal measures that influence our domestic development is the treatment we accord foreign products at our ports—that is, our tariff policy. The primary purpose of a tariff levy is governmental

funds, and in normal times our customs receipts are almost one-half of the total ordinary receipts of the United States Government; a subordinate purpose is to foster and enlarge domestic industry by wise and farsighted adjustment of customs rates and at the same time not unfavorably to affect the cost of living. Heretofore, such industries as employ much labor have by preference been fostered by our customs policy, and in comparatively rare instances only has any other test of eligibility to tariff help been applied; the test of the measure of such protection has been from 'difference in cost of production plus a fair profit' upward to all the tariff would bear. In 1916 Congress created the third of our tariff commissions to help it solve the problem of customs rates fairly and equitably to all. At the same time Congress greatly increased the difficulty of that problem by enacting what it intended and expected to be a set of customs rates on materials and products of the coal-tar chemical industry of such dimensions as to make importation unprofitable and domestic production profitable. Such rates had theretofore been consistently refused by Congress for more than thirty years, because such an industry employed relatively little labor and its products were raw materials for so many domestic manufactures that not only would our cost of living be advanced, but our competitive ability curtailed by such duties. This tariff of 1916 says in effect that, since the work of 2,000,000 of our people can be interfered with because 7000 other people are not here making things indispensable to the 2,000,000, we must have that industry here even if it employs only 7000 people, or, in other words, 'key industry products' must be made in the United States. The problem that now confronts the Tariff Commission is to get together all the material and facts so that Congress can enact a tariff that will provide half our ordinary Government receipts, will not unfavorably affect the cost of living, will expand our domestic industry to its maximum and will prevent its being crippled because of failure of the usual channels of international trade.

"In order that the Tariff Commission may properly discharge its duties to Congress it is necessary for it to have comprehensive and complete detail information on a vast multitude of different subjects and items so arranged and so co-ordinated that it will lend itself to the treatment to which the commission must submit it before a report to Congress can be made. For the purpose of so collecting and collating information the commission has established a technical staff comprising specialists in the various technical branches involved. Among such specialists there is a chemist.

"In reading our tariff enactments, the all-pervasiveness of things chemical is very striking; but only recently has that impressed the general public and obtained recognition from Congress. The chemists' interests do not end with Schedule 'A,' which deals largely with chemicals and with so much of the free list as relates to things allied to those of Schedule 'A,' but they permeate almost each and every one of the fifteen schedules of the act. Obviously, the chemist member of the Technical Staff Commission must examine a host of industries not ordinarily looked upon as chemical in addition to the very large number of industries that are acknowledged to be chemical in greater or smaller degree. His task is most difficult, and its successful execution will require much farsighted, patient and diligent labor on his part and the frankest and fullest co-operation of our industries."

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Dr. M. T. BOGERT, Chairman of the Chemistry Committee of the National Research Council, then followed with an address on the work of the council. His address is not included here, as an address which Dr. Bogert gave on the same subject at the Boston meeting of the American Chemical Society will be found in the report of that meeting on page 384 of this issue.

Mr. WILLIAM S. CULBERTSON, member of the U. S. Tariff Commission, delivered an interesting and important address on "The Tariff Commission and Our Chemical Industries." The keynote of his address was an appeal for a greater co-operation between the chemists in the universities and industries and the Tariff Commission, which is investigating the chemical industries of the country in their relation to the tariff.

Mr. GRINNELL JONES, chemist to the Tariff Commission, in his address on the "Chemical Schedule," dealt chiefly with the developments of the listings of the schedule and showed wherein they could be improved. He mentioned the work of the American Chemical Society in trying to obtain better statistics. This work is going forward at the present time with the co-operation of the Government officials, and the results will be published later. Mr. Jones announced that the Tariff Commission was planning to publish regularly an Information Catalog giving many pertinent facts on the tariff situation. Publication of both Mr. Culbertson's and Mr. Jones's papers is reserved for a later issue.

Wednesday Meetings

On Wednesday afternoon lectures were delivered by M. A. WILLIAMSON of the Norton Company on "The Manufacture and Use of Alundum and Crystolon," and P. A. BOECK of the Celite Corporation on "Increasing Plant Production by Heat Insulation."

On Wednesday evening several very interesting addresses were presented. The address of Dr. L. H. Baekeland will be found below practically in full. We are very sorry that lack of space prevents our publishing the addresses of W. S. Kies, vice-president of the National City Bank, on South American trade, and by C. H. Boynton, president of the Russian-American Chamber of Commerce, on Russian trade.

The Future of Chemical Industry in the United States

BY DR. L. H. BAEKELAND

Member of the Naval Consulting Board of the United States.

Judging from the scarcity of aniline dyes at the beginning of the war, most people made the erroneous deduction that we had no chemical industry to speak of. This is a gross error. As far as the mineral chemical industries are concerned, this country, even before the war, could stand excellent comparison with Germany or any other country. In fact, when it comes to the production of acids and heavy chemicals, the United States, in several of these branches, was decidedly ahead of Germany. This is particularly the case in her important electrochemical industries, which were developed way ahead of those of any other country.

There is no doubt, however, that we were behind in the manufacture of synthetic organic chemicals, which include the coal-tar dyes. But there was nothing strange or abnormal in this situation. The importation of these products in the United States before the war did not exceed $10,000,000 a year, this covering more than 1000 different kinds of products, all of which require special processes of manufacture, and some having to be worked in very small units. The manufacture mainly requires not only good chemists, but also inexpensive skilled labor which it takes a long time to train. As a business proposition, there was little to attract shrewd American business men.

If Germany has specialized in this branch of chemical industry, it was merely because she did not have the same opportunities for enlisting in other fields of enterprise. Here in this country we had new mines to exploit, new fields to cultivate, new railroads to construct, and many more industries of immediate importance claimed the full attention of our men of enterprise or scientific training. No wonder, then, that a little paltry industry of this kind was neglected.

Nevertheless, as far back as the early seventies a few enthusiasts started the manufacture of aniline dyes in the United States. They were making quite some headway, but in 1883 they had to perish through unfavorable tariff legislation. At that time German agents were already at work in this country and were leading our textile manufacturers by the nose, and they helped them in their lobbying for the lowest tariff on dyestuffs, claiming that Germany would serve them, furnishing them with what they called their "raw material." This situation acted as a boomerang and paralyzed our textile industries at the beginning of the war.

Since then this country has realized that we must not estimate the value of the color industry in dollars and cents, but by the direct bearing it has as a key to all other industries. A few cents' worth of the right kind of dyes decides whether a hundred dollars' worth of textiles can be sold or not in the open market. What is most extraordinary, almost a wonder, and bears witness to the flexibility and adaptability of American enterprise, is that in less than three years we should have made ourselves independent of Germany in the line where she had the start on us since half a century.

This awakening of the chemical industry has carried us along also in other chemical lines. Attention has been given to problems which formerly were outside of our natural field of action. We have carried the mass-production of synthetic explosives to a point never dreamed of. With truth it can be said that if it were not for one of our largest chemical manufacturing companies, which promptly rushed to the rescue of the Allies at the beginning of the war and furnished them with explosives of which they were so short, the war might have been ended a year ago in favor of Germany. Since then the chemists of France and England have shown also abundantly what they can do if conditions require it, and everything points out that after this war is over the supremacy of Germany in some of the chemical industries in which she heretofore was a leader will be a thing of the past.

Future Permanence of American Chemical Industry

If anybody asks what have the chemists been doing, let them visit this Exposition and be convinced that our chemists have not been asleep. But you will ask: "Is all this going to last? Are not most of these industries simply war-babies, bound to vanish as soon as peace is declared and conditions again become normal?" Some of these industries undoubtedly will disappear as soon as the war is over, particularly some ill-conceived projects, badly managed and badly financed. Others will have to shift the bulk of their production to other articles; others again may have to reduce their capacity. Then almost all of them will have to be satisfied with smaller profits. The latter effect will not be so much of a detriment as some people may imagine. The apparently high profits of to-day are considerably offset by the uncertainty of obtaining the raw materials and other feverish conditions which make manufacturing more of a gamble than it ever was heretofore. Smaller but steadier profits are more conducive to the sound development of an industry.

As stated before, we already had made a splendid record even before the war in the development of our industries of heavy chemicals, in the mineral or inorganic line. The steady development of these industries will very probably proceed as in the past. Our greatest development will consist in the further extension of industries in the organic field. When the present crisis came, we had no trouble in finding chemists and chemical engineers in the field of acids and heavy chemicals. Our lack of experience was mostly evident in the newer problems of coal-tar dyes and other organic industries. Here, like in other fields of chemical industry, it is not enough to know a chemical reaction on a laboratory scale. It makes an enormous difference whether you are manufacturing by the ounce or by the ton. In a laboratory, operations can be performed in little glass vessels, or in porcelain or expensive platinum. On a manufacturing scale, all this becomes totally different and the difficulty is no longer the chemical reaction itself, but the vessels and the methods of carrying it out. Acids and other substances which attack iron and other metals have to be handled in machinery which can withstand their action and insure not only the highest yields but great purity, and exclude the possibility of accidents. An entirely new industry had to be created for this purpose—the industry of chemical machinery and chemical equipment. But this was not all; the best chemists and best engineers are powerless if they do not have carefully trained and experienced foremen and workmen. Labor in the chemical industries does not count so much by number as by quality and reliability. One careless act of one single workman can blow up a whole plant or stop manufacturing for several weeks. These have been the great impediments during the first months when we had to tackle entirely new industries. Now that we have familiarized ourselves with the conditions, and that we have every right to feel confident in our further efforts, there is every good reason and every good opportunity why we should turn our abilities to other lines of organic industry besides that of the coal-tar industry.

It is said, with right, that one of the reasons why we had no coal-tar industry in the United States was that there was no available coal-tar because our methods of making coke and gas were such as to exclude this raw material as a byproduct. Conditions have changed since then, and now we are abundant producers

of coal-tar, and the quantity of this raw material, from which so many chemicals are made, will undoubtedly keep on increasing for many years to come.

But there are other raw materials in the organic line which hitherto have not been utilized to the proper extent. For instance, our petroleum and natural gas have thus far been used for little else than as a fuel. It only requires research and enterprise to make it a raw material and a starting point of as many valuable products as coal-tar has supplied until now. The same can be said of our agricultural products. In fact, every agricultural product is a starting raw material from a chemical point of view. Starch, sugar or wood may be a starting point for alcohol, one of the most useful chemicals ever introduced to mankind, and for which the future industrial uses are almost limitless as soon as it can be manufactured and distributed at a sufficiently low price. Nevertheless, our chemical engineers have been thinking along inorganic or mineral lines. From now on they have learned to tackle problems in organic chemistry. If they succeed half so well in this new line as they have done in the old, there is very little doubt that this country, with its limitless resources of organic products, will find ample opportunity of building up new chemical industries for products hitherto of little use or scarcely known, but for which a market can be found as soon as they can be supplied at a sufficiently low price and as soon as we become aware of the new possible uses. It will be the story of so many chemical substances which at first found no market and of which sometime afterwards the demand exceeded the supply.

New Attitude Necessary Toward Chemical Industry

I mention this particularly because some short-sighted men are inclined to believe that the chemical industry will be restricted by the present market and by the world competition of other chemical-producing countries. There is no doubt that at first a strong commercial struggle between competing manufacturers will set in. This will be the critical period, and I fear that during this period this country will be at a disadvantage unless we change radically our present attitude. Those who framed the Sherman Law did not consider that if a certain amount of competition is good, too much competition may be killing for all competitors concerned. In reckless commercial competition, the healthy technical efficiency, which is the basis of every sound industry, is frequently overlooked. Several manufacturers in this country, underbidding each other and in the meantime leading to over-production, can hardly compete with those of other countries supported by a paternal government which encourages the formation of trusts or Kartels, and favorizes exportation by subsidies or bounties, as done frequently in the past. These remarks apply specially to Germany. We know that not only had she her political agents distributed in all foreign countries, but she maintained a staff of agents who were always on the watch to detect a weakness in our situation and who never missed an opportunity to mix in our attempts of tariff legislation. The influences which in 1883 killed our dyestuff industry are still at work to-day, when they surreptitiously introduce words of double meaning which jeopardize the intent and purpose of our latest tariff laws. To what extreme measures Germany is ready to go in order to maintain her supremacy in certain industries can easily be guessed by what we have learned of late. In her political machinations in all countries, some glimpses of her intentions can be gained, now and then, by incidents such as the following. On Feb. 1, 1916, in the *Faber-Zeitung* of Berlin appeared the following paragraphs:

> "The German coal-tar dyestuff industry ought, after the conclusion of peace, to be permitted to sell dyestuffs only in Germany and Austria, in Turkey and Bulgaria, until the German textile factories are again fully occupied and all warehouses and stores and all consumers are again supplied with good white, dyed and printed goods. Only then should it be permissible to furnish German coal-tar dyestuffs to neutral or hostile countries.
>
> "If foreign countries begin again soon to receive good German coal-tar dyestuffs, they might easily ruin the business of the German export trade in finished products.
>
> "For the German coal-tar dyestuff industry there are probably two other points to be considered; first, this industry and the German industry in coal-tar products would for the present have no right to sell raw material and by-products to foreign countries, in order not to create unnecessary competition; and, besides, it would be permissible to furnish dyestuffs to America only if the American government should promise to bury for a long time the unjustifiable so-called anti-trust question in connection with aniline-dye interests."

These and many other attempts will be made at first to strangle our new industries. It will depend as much on sound common sense of our legislators as on the skill and science of our chemists and engineers whether what we have gained so brilliantly by splendid constructive work will be lost again through political bungling and ignorance. Fortunately, we have now what we should have possessed long ago, a Tariff Commission, and the quality of the men who have been selected for this give every guarantee that they will be able to do justice to their important responsibilities, provided, however, petty business interests or sinister foreign influences do not succeed in paralyzing their work or cripple their action by simply sidetracking them as so many other useless commissions.

Power Development Important

Then there is another great problem which will have an important bearing on the future of some of our chemical industries. I refer to the power problem. In a country blessed beyond comparison with all the necessary natural resources for a large chemical industry, with a home consumption greater than that of any other country, with an enterprising population, with immense deposits of coal and other sources of fuel, navigable streams, railroads, and ever-increasing methods of land and water transportation, we, nevertheless, are very short of cheap water powers. Our great development of the electrochemical industries in the United States was due to the fact that for the first time we placed at the disposal of our industries abundant electrical current at lower rates than it had been obtainable in the past by means of steam. We became the leaders in those industries. Niagara Falls and its industries became a by-word of electrochemical supremacy throughout the world. Some of the most epoch-making inventions in this branch of chemical industry were encouraged by this condition. Since then other countries have gone us one better in the production of cheap water power. Unless we change our present condition it looks as if our electrochemical

industries, our leading chemical industries, were going to be wrested from us to find a more inviting home in Canada and in Norway. Unfortunately, here again the condition is one of "dog-in-the-manger" politics.

For purposes like electric lighting or traction, or most chemical industries, a few dollars more or less a year expressed in kilowatt-hours amounts to a mere trifle. But when it comes to making chemicals or metals at the very lowest possible cost, then every dollar counts, and here we are unfortunately face to face with the distressing fact that, with our present methods of financing, the fixed charges of our water powers amount to about 90 cents financing and 10 cents engineering. If engineers succeeded in increasing their efficiency of operation 10 per cent, it would only amount to 1 per cent in the total cost. So, if any improvements have to be made, it must be in the financial side of the problem. Meanwhile every one advances his own arguments why it should be this way, and every one is more or less right—from his personal standpoint. Capitalists say: "Some of our Government laws about the utilization of our water powers are so uncertain and threatening that we prefer to invest in less risky enterprises." Then our rates of interest in this country are considerably higher than they are in Europe. Some other persons have proposed that the United States Government should use its own excellent credit and thus be able to issue bonds for water powers at low interest, in the same way as the Panama Canal has been constructed. With our wasteful methods of financing and banking, and the many middlemen, it costs usually about 9 per cent to accomplish this result by the time the bonds are floated and put in the hands of the hesitating investor. This puts the annual cost of some of our cheapest water powers at $10 a horsepower-year, of which $9 is for interest and bonded charges and $1 for general operation and maintenance expenses, to which has to be added profit for dividends. But with interest at 4 per cent the cost per horsepower would suddenly be reduced to $5 to $7 per horsepower-year, which brings it closer to that of some of the water-power developments in Norway. Then, again, others say that the Government has no right to participate in any such enterprise, or that it is unprepared and unfit for any such business operation. To this others retort that the erection and operation of a hydroelectric plant is much easier and less expensive for the Government than for private companies, because the Government has already in its power the question of extending the navigability of streams, which, by the way, has always been a never-ending source of "pork-barrel" appropriations. Streams are made navigable by the erection of dams. By the proper selection of stream and location the cost of the dam can be made to furnish the most important part of the total outlay for a hydroelectric plant; all that is necessary is to add the turbines and the electric equipment for obtaining at somewhat increased cost a first-class hydroelectric plant, furnishing forever electric current for any purposes. A hydroelectric plant as a Government enterprise would not involve much of a new departure as compared with that splendid example of good engineering, the Panama Canal, which is a national monument of efficiency, and which, similar to the present problem, is an asset for national defense in time of war, while in the meantime it is an aid to private shipping enterprises. The methods of hydroelectric plants are, by this time, well established and well known, and leave little scope for further improvement except the enormous cheapening which is possible for such plants in the reduction of fixed charges by very economical financing.

These are some of the dark points on the horizon of our chemical industries. What will happen depends very much whether in the future our legislators will look at everything from a political or a one-sided standpoint, or whether they shall have learned in earnest to utilize the advice of competent men, and put the welfare of the United States before sectionalism and personal political ambition.

Thursday Meetings

The manner in which the South is realizing and exploiting its industrial resources was thoroughly brought out in the symposium Thursday, with Dr. Eugene P. Schoch, of the University of Texas, presiding. The keynote of the program was given in the paper of C. H. Crawford, of the Nashville, Chattanooga & St. Louis Railway. His title was "Ahoppa Awan Tewa"—"The Dead, their Day," referring to a Zuni Indian ritual on the mythical subterranean origin of their race. The analogy was found in the way the South has "come up" and is becoming recognized as our country's greatest undeveloped asset. Other speakers and their papers were: V. V. Kelsey, "Building a Complete Cycle of Chemical Industries on the Clinchfield." T. P. Maynard, "Interpretation of the Mineral Resources along the Central of Georgia Railway," E. A. Schubert, "Development of Chemical Industries Along the Norfolk & Western Railway," J. H. Watkins, "Railroad Industrial Preparedness."

The joint session of the New York sections of the A. I. M. E. and American Electrochemical Society was presided over by Mr. J. V. N. Dorr. After introductory remarks by President P. N. Moore of the A. I. M. E. and President C. G. Fink of the American Electrochemical Society a program was presented on the production and uses of ferro-alloy metals, with relation to the war. Chrome mining and concentration, with special reference to a recent development in Canada, was presented by C. S. Newcomb. The importance of nichrome to the electrical and metallurgical industries was outlined by W. B. Driver. In the absence of S. H. Ball, his notes on ferro-molybdenum were read by the Secretary. Some impressions on conditions in the metallurgical industry of Europe gathered during a recent trip abroad, were prepared by Dr. George K. Burgess, and in his absence read by the Secretary.

Friday Meetings

One of the most important technical sessions of the exposition was that of the New York Section, American Chemical Society, at which "The Chemist and the Banker" was discussed. Mr. Arthur D. Little represented the chemist and Mr. G. A. O'Reilly, of the Irving National Bank, New York, appeared for the banker. Owing to the late hour at which this symposium was presented we are obliged to defer a full report until a later issue.

Impact Tests and the Determination of Resiliency

By Georges Charpy and André Cornu-Thenard*

The Copenhagen Congress of The International Association for Testing Materials after discussing the official report presented by one of us[1] designated a special commission (Commission No. 26) intrusted with the task of determining a working process to be adopted in resiliency tests and of studying the correlation existing between the results of those tests and the way in which the metallic parts act in service.

The researches in this paper bear only on the first question, which must be elucidated before being able to approach logically the second one. Made in 1913 and 1914, they were intended to serve as a basis for deliberation of Commission No. 26, leading to suggestions to be submitted to the Congress which was to be held at Petrograd in 1915. To make their value as convincing as possible, we took certain precautions upon which we are insistent, because it seems that while studying the present subject, experimental precision has formerly been somewhat neglected. Most experimenters who have published their researches upon the bending of metals through impacts on notched bars appear to have given up the idea of obtaining any series of results free of accidental differences. Some attribute such irregularities to the mode of testing; others blame the heterogeneity of the metals employed.[2]

It is important to decide between those two opinions; the first, to our minds, would unquestionably lead to the entire elimination of this mode of testing. As to the second, on the contrary, it would be proper to ascribe a special sensitiveness in the bending test through shocks upon notched bars capable of detecting certain physical states not revealed by any other known test, and whose influence from a practical point of view cannot be deliberately overlooked. This sensitiveness would even offer exceptional interest and justify a deep study of the question.

To demonstrate the soundness of the latter point of view, it was necessary to prepare metals which, under prescribed conditions, would give concordant results within well-defined limits at slight distances from each other. In that we succeeded, as will be seen later—and thus results were obtained the regularity of which is comparable to that given by any other mechanical test.

Moreover, when a suggestion lent itself to controversy and was the subject of contradictory determinations on the part of various experimentors it seemed to us that any new series of determinations could never be indiscriminately applied. Therefore we deemed it proper to submit the results of our own tests to a certain number of authorities for examination. We therefore invited every member of Commission 26 to witness the performance of a full series of determinations made in the Laboratory of the National Conservatory of Arts and Industry, by the staff of that institution. Our results have thus received a sort of official confirmation.[3]

The method of the prescribed work being thus clearly outlined, the subject matter of the present paper consists of three main divisions:

1. Preliminary determinations.
2. Preparation of a series of bars of equal resiliency.
3. Determination of the influence of different variables.

PRELIMINARY DETERMINATIONS

Mathematical Expression of Experimental Uniformity.—It was necessary to clearly define the limits of error in the experiments to be used as a guide in procuring a series of bars of equal resiliency, and to permit us to determine beyond a doubt the influence of the various factors entering into the impact test.

The following statements apply to all kinds of experiments, especially to the shock-bending tests referred to later, and also to the hardness tests which were often made.

Suppose that n bars were tested and all broken under the same conditions; we obtain n values of the resiliency R, the arithmetical average of which gives the mean resiliency R_m. The uniformity or consistency of the experimental results is defined by noting:

The mean error e_m, which is the arithmetical average of the absolute values of the difference $(R\text{-}R_m)$ between the individual resiliences and the average resiliency; and the maximum error, or the difference between the extreme individual tests.

Likewise one may compute the mean relative error E_m, which is the ratio between the mean error e_m and the mean resilience R_m.

We may infer that the regularity of a series of determinations is satisfactory when the value of the mean error or the mean relative error is inferior to some agreed value. In practice, it suffices when the mean relative error is maintained below 5 per cent.

Determination of the Sensibility and Comparability of Apparatus.—In the first place we had to make it clear that the irregularities referred to above did not come from the apparatus but rather from the material to be tested: In other words, it was important to ascertain whether a suitably constructed apparatus, satisfactory in principle, would remain constantly consistent with itself or with any other piece of apparatus meeting the same requirements both as to principle and construction.

For that purpose, we have employed unnotched bars so as to confine the determinations to a well-defined bend without a break; in that manner the slight and local irregularity liable to exist within the metal was not perceptibly noticeable. We will not dwell upon this part of our researches—previously described in the *Revué de Metallurgie*,[4] and shall confine ourselves to presenting a few general results, so as to give first an idea of the precision obtainable with well-constructed

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*Translated from Revué de Metallurgie, March-April. 1917, 14th yr., No. 2, almost entire.

[1] This report appeared in the Revué de Metallurgie, December, 1909. See also the Report presented at the New York Congress in Revué de Metallurgie, December, 1912.

Consult the following for further information on the subject: G. Charpy.—Observations upon tests of bending metals through shock of notched bars. Bulletin, Societé des Ingénieurs Civils, 1901, (1) 848 and 1904, (II) 468.

G. Charpy.—Report on testing metals by impact (Copenhagen Congress). International Association for Testing Materials; 1909, Article No. 7.

G. Charpy.—Report on impact tests and the labors of Commission 26 (New York Congress). International Association for Testing Materials: 1912, Paper No. 9.

[2] The latter opinion has been expressed clearly in a paper presented at the New York Congress by M. Belanger, in which he writes: "Even among steel known as being the most homogeneous (crucible steel, electric steel) the resiliencies vary 100 per cent within a few centimeters distance. Within a meter or two they vary 400 per cent at times."

[3] The certificate covering the experiments made during that session appears at the end of the French article and confirms the determination in every point.

[4] G. Charpy and A. Cornu.—Remark upon the calibration of impact apparatus. Revué de Metallurgie, November, 1913, page 1233.

impact apparatus and then of its application to the calibration of testing machines.

Each series of experiments summed up in one line of Table I comprises five bars. Two series of test pieces of different sizes were also tested with each one of the two pendulum-shaped blocks at our disposal.

TABLE I

Dimensions of Bar	Kind of Metal	Mean Work Absorbed in Bending	Mean Error e_m kg.-m.	Mean Relative Error E_m	Extreme Value, kg.-m.
30 kg., pendulum:					
53.3x10x5	For cannon	9.954 kg.-m.	±0.093	0.9%	9.72- 10.11
53.3x10x6	For cannon	15.446	±0.216	1.4	15.04- 15.72
300 kg., pendulum:					
200x30x13	Soft boiler plate	166.508	±1.678	1.0%	163.71-169.3
160x30x15	For cannon	255.807	±1.144	0.4	254.57-258.66

The regularity presented by these tests was not easily acquired. In the course of this study we realized the importance, from the point of view of experimental testing, of the exact shape of the curved parts in contact with the bar (head knife and supports) and of the perfection of the machine work on these elements. Naturally we made note of those observations in the subsequent tests upon notched bars.

The examination of this table shows: First, that carefully prepared small unnotched bars give practically identical results in the same piece of apparatus, under the same conditions, and second, that the irregularities between successive tests appearing when the impact tests are used upon notched bars are not attributable to the testing machine, but rather to the tested material.

Similar tests performed with a vertical drop-hammer brought forth similar results. One may proceed still further and conclude by saying that the above certifies, first, the relative regularity of two kinds of impact apparatus, and, second, concordance or discordance in the graduations placed on these two machines.

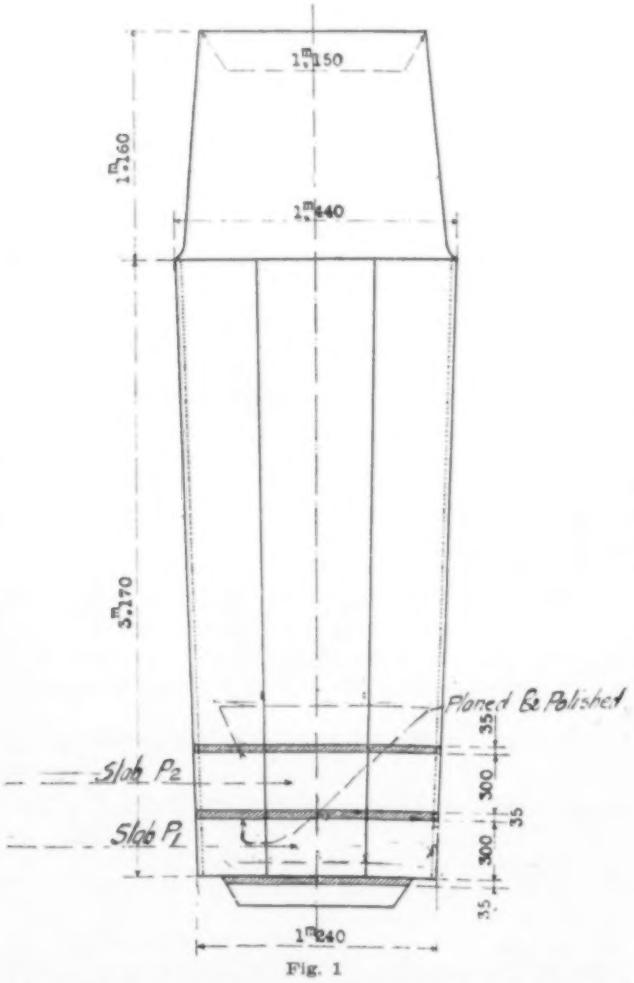


Fig. 1

Elevation of a 45-ton ingot from which has been taken the medium steel used in testing.
Slab P_2 = section of the ingot which produced the blocks for forging the test bars (regarding the distribution of these blocks, see Fig. 3); the upper face has been studied as to its structural homogeneity.
Slab P_1 = section of the ingot forming its base; the upper face has likewise been studied macrographically.

II.—PREPARATION OF BARS OF EQUAL RESILIENCY

(A) PRELIMINARY TESTS

Preparation of the Metal.—We endeavored as far as possible to exclude chemical and physical heterogeneity in the metal by having recourse to the process previously mentioned by one of us, and which consists in removing a relatively small fragment from the sound part of a large sized ingot. As to the steel (metal A) used in the greater part of our preliminary studies, we were able to carry things to extremes; indeed, we had at our disposal a 45-ton ingot from which we had cut small blocks of 25 kg., thus each of the latter represented only the 1/1800 part of the original metallic mass. We describe in full below the verifications made by us in this particular case, before utilizing the strip of the ingot reserved for our investigations.

Two slabs P_1 and P_2, 300 mm. in height, were taken out from the base of the ingot (Fig. 1), the upper sections of each of these slabs were polished, etched first with iodine and then with sulfuric acid, without manifesting any macrographical heterogeneity.

Slab P_2 was afterward sawed into two equal parts while reserving between these two parts a vertical slice T_2 50 mm. thick, so as to study the metal both from the mechanical and chemical standpoints along the height of that portion of the ingot. To that end, this slice having been subjected to a tempering so as to efface any strains due to casting, was explored over its entire surface by the Brinell principle (39 tests distributed as in Fig. 2).

These showed an average hardness of 153.4 ± 5.6, that is, a mean relative error of 3.6 per cent only. Then filings were taken from various points of the section which were analyzed and yielded very regular results, summed up in Table II.

The filings for chemical analysis were procured from the points noted in Fig. 2.

The metal showing satisfactory homogeneity, we then cut from slab P_2 parallelopipedons A, 100 x 100 x 300

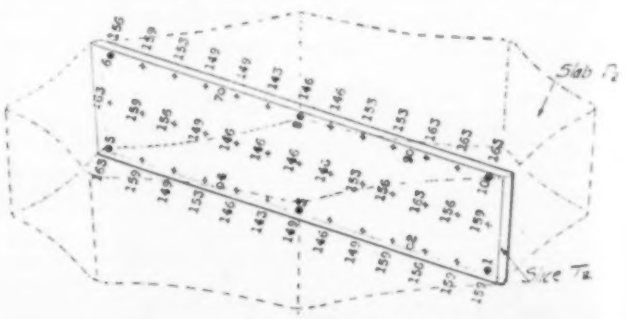


Fig. 2

Perspective view of slice T_2 removed from slab P_2 along a diametrical section. Upon this slice are indicated; first, the indentations (+) and the corresponding Brinell hardness numbers; and second, the marks (O) where filings were taken for chemical analysis.

TABLE II

	C	Si	Mn	P	S
○ No. 1	0.33-0.34	0.28	0.77	0.022	0.014
○ No. 2	0.33-0.32	0.27	0.75	0.020	0.014
○ No. 3	0.33-0.29	0.28	0.74	0.017	0.010
○ No. 4	0.33-0.28	0.28	0.74	0.018	0.010
○ No. 5	0.37-0.38	0.27	0.76	0.022	0.014
○ No. 6	0.30-0.32	0.28	0.77	0.022	0.014
○ No. 7	0.28-0.27	0.26	0.74	0.019	0.010
○ No. 8	0.26-0.32	0.26	0.72	0.017	0.010
○ No. 9	0.30-0.34	0.28	0.75	0.019	0.014
○ No. 10	0.26-0.29	0.27	0.76	0.024	0.012

mm. concentrically distributed about the axis and within the middle section of the ingot, according to Fig. 3.

Influence of Superficial Layers.—Each block formed into a square bar 34 x 34 mm. yielded a series of small bars; each of these bars was labeled with the letter denoting the metal, the number of the original block, and the serial number of the piece in the bar. Thus the eighth small piece from the bar originating from the fifth block of metal *A*, was labeled *A*. 5:8. A series of determinations comprises all the small bars bearing the same order number; thus the experiments presented under the notation *A*:6 have utilized the sixth test piece from each one of seven bars from metal *A*.

These small test bars were then reheated to efface any strain due to the rolling, machined to the dimension 30.5 x 30.5 mm., heat treated, tempered and annealed in a small oven heated with industrial gas in lots of approximately 50. The temperature was registered with Lè Chatelier pyrometers at various points in the mass.

After finishing, drilling and notching the test pieces we obtained from the impact machine the results in Table III.

TABLE III

Series of Small Bars	Individual Resiliency	R_m	e_m	E_m	Extreme Values	Individual Hardness	H_m	e_m	E_m	Extreme Values
	I 21.21					189				
	II 15.16					188.5				
	III 14.62					193				
A: 1	IV 10.19	16.57	±6.3	38.0%	27.31-4.18	188.5	187.4	±2.6	1.3%	193.0-183.5
	V 4.18					185.5				
	VI 27.31					183.5				
	VII 23.31					184				
	I 25.48					190				
	II 12.48					191				
	III 13.28					199.5				
A: 2	IV 4.78	15.27	±7.9	52.1%	25.48-2.60	186	188.8	±3.9	2.0%	199.5-180.0
	V 2.60					188				
	VI 22.72					180				
	VII 25.48					187.5				

In spite of every precaution we developed the irregularities so frequently mentioned in resiliency tests even while maintaining a constant hardness. Through certain observations, however, we were led to wonder whether the superficial layers of the test pieces had not undergone changes in the course of the heat treatments, such as to affect the results in a perceptible manner. To ascertain this we simply planed off the sides of the following small bars; thus, the 7 small bars

A:5 were planed off 1 mm. (notching section 15 x 28).
A:7 were planed off 2 mm. (notching section 25 x 26).
A:8 were planed off 3 mm. (notching section 15 x 24).

The results of the impact were then as in Table IV.

The experiment seems to be conclusive; the slight planing of the superficies lessens the mean relative error from approximately 20 per cent to 8 per cent; the hardness tests on the planed surface, on the contrary,

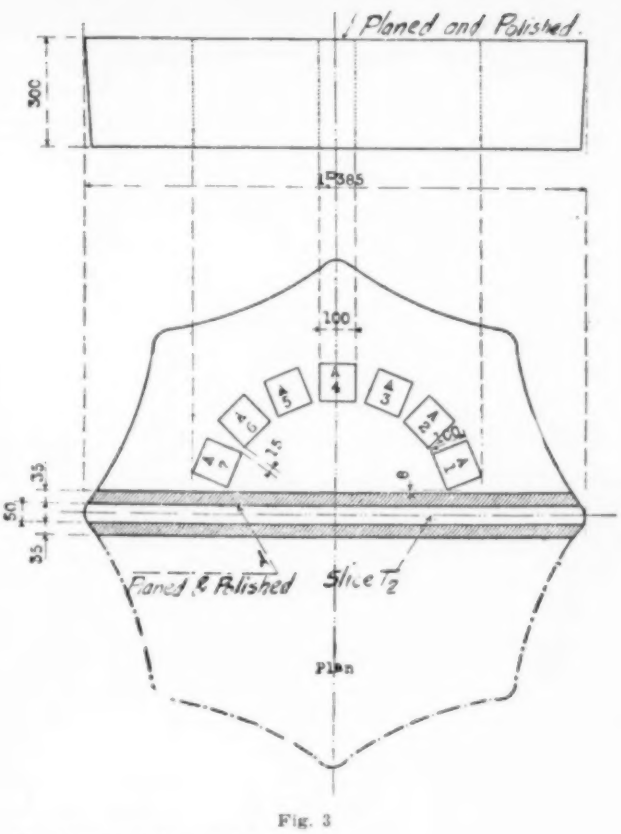


Fig. 3

Elevation and plan of slab P_2.

The plan shows blocks A, which have been cut out at equal distances from the center and the edges of the ingot, to better utilize the sound part of the metal only. Each of these blocks weighs 25 kg., which is 1/1800 part of the entire mass (45 tons).

reveal no corresponding variation but remain perfectly uniform. The elimination of the superficial layers of the bars after heat treatment is now one of the first conditions to be taken into consideration in order to realize a uniformity in the results of a series of impact tests.

TABLE IV

Series of Small Bars	Individual Resiliency	R_m	e_m	E_m	Extreme Values	Individual Hardness	H_m	e_m	E_m	Extreme Values
	I 20.51					175				
	II 23.04					174.5				
	III 10.13					182.5				
A:5	IV 27.60	19.05	±4.0	20.9%	27.60-10.13	178.5	177.0	±2.0	1.1%	182.5-174.5
	V 15.66					177				
	VI 18.35					174.5				
	VII 18.05					177				
	I 25.73					173.5				
	II 25.73					178.5				
	III 14.36					180				
A:7	IV 22.32	21.54	±2.77	12.8%	25.73-14.36	174.5	177.0	±2.3	1.2%	180.5-173.5
	V 21.99					180.5				
	VI 21.65					176				
	VII 19.03					176				
	I 22.50					169				
	II 20.39					179				
	III 16.67					182				
A:8	IV 23.57	20.17	±1.69	8.3%	23.57-16.67	179.5	177.6	±3.3	1.8%	182.0-169.0
	V 18.00					181.5				
	VI 20.04					175				
	VII 20.04					177.5				

Influence of Temperature of Rolling.—A few experiments made upon another steel led us to think that the temperature of rolling might affect the resiliency; and to reassure ourselves of such an influence upon metal A we rolled two blocks from our 45-ton ingot, one at an approximate temperature of 1200 deg., the other at nearly 800 deg., the bars thus secured were reheated to 900 deg. and cooled in the oven; the small bars

originating therefrom were hardened and annealed, then machined to 30 x 30, drilled and notched.

Results of this test are presented in Table V.

TABLE V

Rolling Temperature	Number of Bars Tested	RESILIENCE TESTS			Extreme Values	HARDNESS TESTS			Extreme Values
		R_m	e_m	E_m		H_m	e_m	E_m	
800°	5	29.05	±5.97	20.5%	44.0 -22.71	173.4	±3.32	1.9%	178.0-166.2
1200°	5	22.23	±1.17	5.2%	24.23-20.02	170.1	±1.72	1.0%	172.5-167.5

Till now we had conceded that the more or less pronounced hammer-hardening occurring in the course of rolling or forging was completely effaced by a suitably selected subsequent heat treatment. This table, however, brings out the fact that even if this is true with the hardness of the specimen, it is not true regarding its resiliency. Moreover, we verified the fact that micrography itself no longer showed any structural difference between cold-rolled and hot-rolled metal after heat treatment.

Influence of Variation in the Heat Treatment.—These first results having been acquired, we then endeavored to eliminate the influence of superficial layers and the temperature of rolling by preceding thus: Another block of metal A was rolled into a bar of 35 mm.² cross section; the latter was first quenched, then it was cut into pieces sufficient to form small bars 160 mm. long; these same fragments were subjected to a heat treatment (hardening and annealing) in the above described manner, then reduced to 30 x 30, bored, notched and tested. Series of tests were then made upon five consecutive small bars from the same strip.

The results, from among the numerous determination, were as follows:

TABLE VI

Metal	A
Number of bars tested	5
Mean resiliency R_m	16.3
Mean error e_m	±1.22
Relative error E_m	7.5%
Maximum resiliency	18.57
Minimum resiliency	13.81

The results shown in this table did not yet manifest the uniformity which we hoped to reach.

It seemed to us that the method of procedure in the heat treatment could be improved upon, and accordingly we determined to heat all the strips of a given series simultaneously in a lead bath.

After rolling the original blocks into bars and reheating the same, the small pieces, 35 x 35 x 160 in dimension, were arranged in groups of 14 or 23 (into bars or half bars respectively) in the basket, as shown in Fig. 4. These baskets were immersed in succession into pots of molten lead at various temperatures.

The mode of operation adopted follows:

The first bath (duration of immersion, 20 minutes) brought the metal to approximately 400 deg., the second (duration of the immersion, 30 minutes) brought it to a temperature but a few degrees lower than the desired temperature, so that the temperature of the third bath (duration of the immersion, 30 minutes) could not be perceptibly lowered (20 deg. at the maximum) by the addition of the articles. This temperature could then be maintained quite constant, and it was registered with great precision. Hardening was done by immersing the

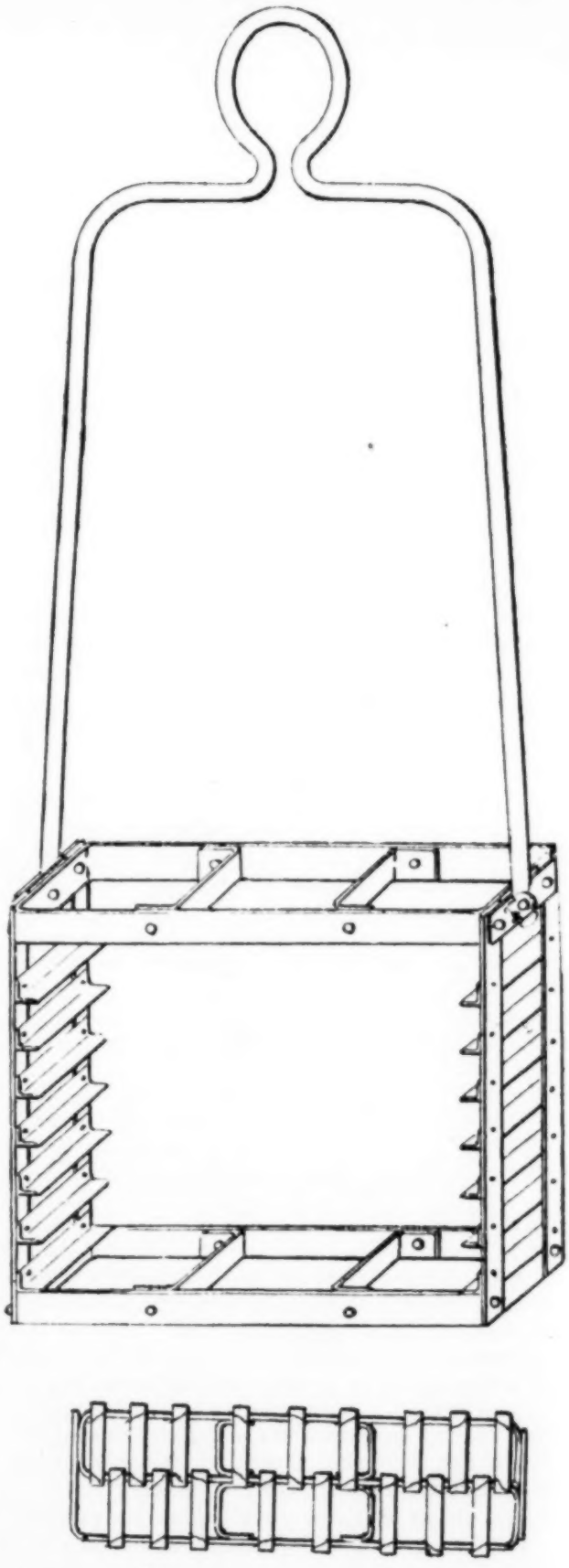


Fig. 4.

Perspective view of the type of basket used in the heat treatment of small bars and a plan of one of the shelves.

The small bars are fixed with wire and at equal distance from each other upon shelves; and the loaded shelves are placed into the basket. Then the apparatus is plunged in succession into the various metallic baths for re-heating and finally into the quenching bath.

basket and all the bars simultaneously into water or oil, according to the grade of the metal; cooling after reheating took place in air.

The bars thus treated were afterwards finished to 30 x 30 x 160, drilled and notched. The tests made under those conditions upon metal A showed a uniformity superior to any previously obtained; the results are included in the following paragraphs:

FINAL TESTS

Summary of Results.—Table VII sums up the results obtained with Metal A, in small bars of 30 x 30 and 10 x 10.

TABLE VII

Series		Types of Small Bars (Copenhagen Notch)	Individual Resiliency	R_m	e_m	E_m	Extreme Values
Metal A:	I	30x30x160 mm.	23.01	24.11	±0.88	3.6%	25.48-23.01
	II		24.85				
	III		24.23				
	IV		25.48				
	V		23.01				
	1	10x10x53.3 mm.	16.18	16.42	±0.20	1.2%	16.92-16.18
	2		16.43				
	3		16.92				
	4		16.43				
	5		16.18				

The uniformity of this series of tests is amply sufficient; it is clearly superior to all those heretofore reached: we may infer therefrom that the preparation of the bars is satisfactory. We then took blocks from a medium-steel "J" containing 1 per cent nickel (original ingot, 25 tons), which were subjected to the successive operations described in the preceding paragraph. For comparison, we added a series of commercial copper bars quenched at 800 deg. to these two series of steel bars, each having five members. The results obtained are shown in Table VIII.

Conclusions.—Results shown in Table VIII prove the possibility of reaching a uniformity analogous to that of tension or hardness tests in resiliency tests upon steel bars of various compositions or upon copper. Moreover, the series of experiments previously summarized clearly undermines the opinion of some authors, partisans of the sharp notch, that the sensitiveness of the impact test is considerably lowered by the use of the cylindrical notch called "Copenhagen." We find complete concordance with the same metal and with the same shape of bars cylindrically notched when due care is taken and incoherent results otherwise. The regularity obtained is due to an improvement in the mode of preparing the test material.

TABLE VIII

Series		Types of Bars (Copenhagen Notch)	Individual Resilience	R_m	e_m	E_m	Extreme Values
Metal J	I	30x30x160 mm.	18.10	17.89	±0.13	0.7%	18.10-17.81
	II		17.81				
	III		18.10				
	IV		18.10				
	V		17.81				
	1	10x10x53.3 mm.	12.16	12.48	±0.34	2.7%	13.07-11.93
	2		12.62				
	3		12.62				
	4		13.07				
	5		11.93				
Metal P	I	30x30x160 mm.	10.08	9.98	±0.15	1.5%	10.08-9.59
	II		9.59				
	III		10.08				
	IV		10.08				
	V		10.08				
	1	10x10x53.3 mm.	5.13	4.76	±0.15	3.3%	5.13- 4.63
	2		4.63				
	3		4.63				
	4		4.79				
	5		4.63				
Copper	I	30x30x160 mm.	12.35	12.14	±0.27	2.2%	12.61-11.83
	II		12.09				
	III		11.83				
	IV		12.61				
	V		11.83				
	1	10x10x53.3 mm.	4.76	4.95	±0.23	4.6%	5.41- 4.76
	2		4.76				
	3		5.08				
	4		5.41				
	5		4.76				

These observations made, we may sum up the precautions taken by us in producing a series of uniform bars as follows:

First—It is important, of course, to select a sample of homogeneous metal taken from the soundest part of an ingot; but the results on steel P, coming from a stock ingot of 2.5 tons, show clearly that it is useless to insist upon abnormally large blocks of metal.

Second—The superficial layers of the bars after rolling and heat treatment are to be eliminated. The disturbances on the surface (which are to be explained later) are more or less pronounced according to the nature of the metal. Usually, we begin with bars of 35 x 35 mm. for the preparation of smaller bars 30 x 30, and with bars of 15 x 15 mm. for the preparation of smaller bars, 10 x 10.

Third—The temperature of forging or rolling is to be as uniform as possible within the same series; especially in the case of the single bar it is well to discard a large portion at each end so as to eliminate the parts which are abnormal.

Fourth.—It is indispensable that thermal treatments be given under conditions as regular and precise as possible.

III.—INFLUENCE OF THE DIFFERENT VARIABLES IN THE IMPACT TEST

We were enabled to study the influence of the different variables which may intervene in the impact test, having once established a homogeneous material. It was no longer necessary to consider a quantity of more or less discordant results, or to note its average while having recourse to the theory of errors. In our tests we simply broke five bars for one determination. We give in Table IX the mode of operation adopted.

Precision of the Adopted Method.—It is necessary to ascertain whether the variation of one of the conditions of the test had or had not a perceptible influence upon the results. To do this we prepared a series of ten small bars as uniform as possible, and then determined the mean resiliency R_m of the series by breaking five of them in a normal manner. It is conceded that the same mean resilience R_m could be obtained after trying likewise the other five, within an approximation of $\pm n$ per cent.

We then vary that condition of the test under examination and break the five remaining bars, which gives a mean resiliency P_m.

We regard the said influence as practically negligible if the difference R_m—P_m is nearly n per cent, the number which defines the precision of the experimental results, as noted above.

These preliminary definitions established, we studied in succession the influence of the following different variables: Height of drop, weight of the pendulum and

Table IX

Series		Height of Drop	Velocities, M.			Duration of the Test, Sec.	Individual Resiliencies	R_m	e_m	E_m	Extreme Values
			Initial	Remaining	Mean						
Steel O	6 I	6.45	11.25	10.28	10.76	0.0012	9.84	9.76	±0.61	6.2%	10.31–8.91
	6 II						8.91				
	6 III						9.38				
	6 IV						10.31				
	6 V						10.31				
	6 VI						9.84				
	7 I	4.31	9.20	8.20	8.70	0.0015	9.86	9.55	±0.71	7.5%	10.79–8.01
	7 II						8.01				
	7 III						8.94				
	7 IV						9.86				
	7 V						10.79				
	7 VI						9.86				
	8 I	2.20	6.57	5.11	5.84	0.0022	10.67	9.97	±0.34	3.4%	10.67–9.29
	8 II						9.29				
	8 III						9.62				
	8 IV						9.97				
	8 V						10.32				
	8 VI						9.97				
Steel J I	1	3.87	8.87	7.55	8.21	0.0036	18.10	17.98	±0.13	0.7%	18.10–17.81
	2						17.81				
	3						18.10				
	4						18.10				
	5						17.81				
	6	1.15	4.83	1.83	3.33	0.0090	18.15	17.28	±0.56	3.2%	18.15–16.68
	7						16.68				
	8						17.08				
	9						17.81				
	10						16.68				
Steel P I	1	3.87	8.87	8.14	8.50	0.0015	10.08	9.98	±0.15	1.5%	10.08–9.59
	2						9.59				
	3						10.08				
	4						10.08				
	5						10.08				
	6	0.58	3.44	0.70	2.07	0.0062	9.63	9.79	±0.19	1.9%	10.21–9.51
	7						9.85				
	8						10.21				
	9						9.75				
	10						9.51				
Copper	1	3.87	8.87	7.99	8.43	0.0035	12.35	12.14	±0.27	2.2%	12.61–11.83
	2						12.09				
	3						11.83				
	4						12.61				
	5						11.83				
	6	0.71	3.80	1.25	2.50	0.0120	11.34	11.12	±0.29	2.6%	11.42–10.71
	7						11.42				
	8						11.34				
	9						10.81				
	10						10.71				

of the anvil block, type of the apparatus, and type of the notch.

Influence of the Height of Drop.—The height of drop of the block in impact tests is often thought to have great influence; however, it is diversely interpreted. While M. Belanger admits diminutions of the resiliency up to 100 per cent as the height of the fall lessens from 4 m. to 1 m., M. Fremont announces differences for a certain steel which he does not reduce to figures, but which he seems to consider as being still more important than those indicated by M. Belanger, but of opposite effect.

The tests offered here were made on two different pendulum-shaped blocks: one having a maximum fall of 6.45 m., the other 3.87. Table IX gives the results of this experimentation. The bars employed were Copenhagen type, 30 x 30 x 160.

Those tests bring out the fact that the influence of velocity in the impact is practically negligible within the limits used by us (11.25 m. to 3.40), and which are not exceeded with the ordinary laboratory apparatus.[6]

The small effect of the height of drop is more easily understood as one considers not the velocity of impact (or height of drop), but the mean duration of deformation, whose variations are much less pronounced. One may approximately compute the time of deformation, having given the initial and final velocities. In operating thus upon the experimental results we realize, in the case of steel P for instance, that the drop height may vary in the proportion of 7 to 1, and similarly the remaining velocity after impact in the proportion of 12 to 1, without the average duration varying more than 15 to 62/10,000 of a second.

Besides, one may compare this result with the one reached by Sarreau and Vieille, in their remarkable experiments upon the measurement of pressure in explosions where they found that the deformations produced in their cylinders at a given pressure remained practically identical, when the duration in the impact varied 1/10 to 3/10,000 of a second.

One of us had previously demonstrated that, to have the results of the test influenced in a perceptible manner, the average duration of the deformation must be greatly increased; it is not surprising then that the slight variations in the duration of deformation attainable in impact tests are without noticeable influence upon the results.

Influence of the Block Weight and That of the Anvil Block.—Facing a difficulty in defining clearly what is meant by the expression "anvil block weight" we resolved to compare two like pieces of apparatus with each other; the principal difference being in their size. The question of the height of drop being eliminated, the only two variables in this test were consequently the weight of pendulum and of the anvil. (See Fig. 5.)

To that end, two pendulums were used: one of 307

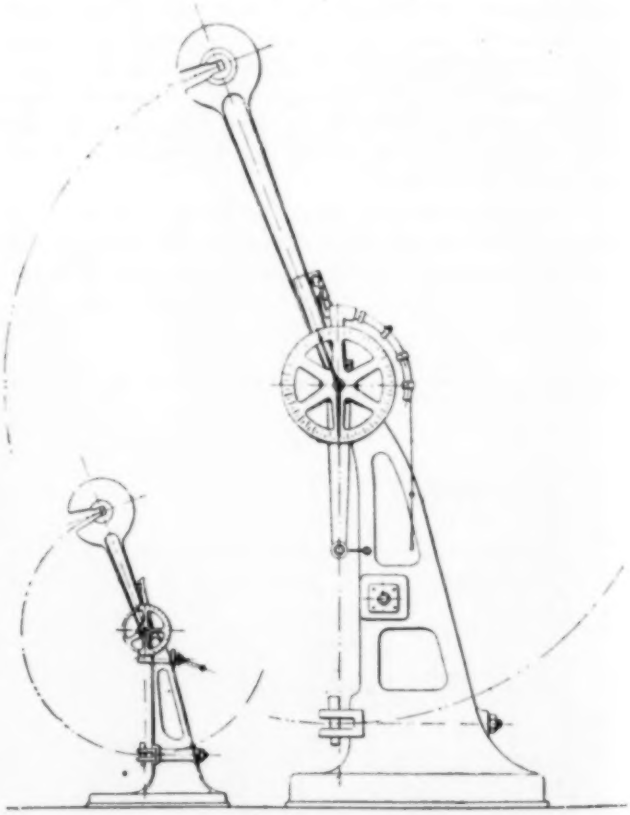


Fig 5.

Diagram of the two pendulum-shaped blocks used to study the influence of the weight of the striking mass and that of the anvil block.

On the right: the 307 kg-m. pendulum; weight of the striking mass, 96.25 kg.; drop height, 3.87 m.; weight of the foundation frame, 1800 kg.

On the left: the 30 kg.-m. pendulum; weight of the striking mass, 22.31 kg.; drop height, 1.45 m.; weight of the foundation frame, 190 kg.

[6] This result has been fully confirmed by the experiments made at the Conservatory of Arts and Industry.

kg-m. (weight of the mass, 96.25 kg.; height drop, 3.87, support distance, 80 mm.); the other 47 kg-m. (weight of the mass, 32.14 kg.; drop height, 1.49; support distance, 80 mm.).

The ten small bars of one single series (20 x 20 x 107 mm. notched half way through) were distributed into two lots of five; one of those lots was tested upon the 307 kg-m., the other upon the 47 kg-m. apparatus.

The results were as follows:

TABLE X

	R_m	e_m	E_m	Extreme Values
307 kg.-m. block	18.61	±1.04	5.6%	20.2 -16.52
47 kg.-m. block	19.90	±1.70	8.5%	21.96-16.99

From the average relative error denoting the precision of the test, these two results may be practically considered as identical. The 47 kg-m. pendulum was of old construction and seemed to undergo deterioration in use. We therefore resumed the same tests with a new apparatus, reducing the dimensions of the small bars to 15 x 15 x 80 mm.

In this second series of determinations we used (Fig. 5):

1st.—The same 307 kg-m. pendulum as above (distance of supports, 60 mm.);

2nd—A 30 kg-m. pendulum (weight of the mass, 22.31 kg.; drop height, 1.45 m.; distance of supports, 60 mm.).

The weights of the foundation frame of the two apparatus were respectively 1800 kg. (307 kg-m. block) and 190 kg. (30 kg-m. block). It is to be presumed that the weight of the anvil block was approximately proportional to the weight of the frame

We give in Table XI the results obtained:

TABLE XI

Pendulums	Series of Bars	Individual Resiliencies	R_m	e_m	E_m	Extreme Values
307 kg-m.	C. 11 I	19.72	18.67	±0.65	3.5%	19.72-17.48
	II	18.97				
	III	17.48				
	IV	18.97				
	V	18.22				
30 kg-m.	C. 12 I	19.31	17.93	±0.86	4.8%	19.31-15.93
	II	18.44				
	III	15.93				
	IV	17.77				
	V	18.22				

This time the consistency of the individual determinations of each series is very satisfactory, and the mean resiliencies differ only from each other by 0.74 kg-m., that is, by 3.9 per cent of the higher figure.[6]

Hence we may conclude that, within the limits of precision reached, the weight of the pendulum block and that of the anvil block do not exert any influence over the impact test.

The results presented above seem to us so much the more interesting because in these experiments the two apparatus acted in a manner quite abnormal. Breaking the bar took up hardly the tenth part of the available power of the larger while it took up almost the full power of the smaller.

Contrast Between Various Types of Apparatus.—

[6]This series of determinations was duplicated at the Conservatory under analogous conditions. The mean resiliencies obtained were respectively of 21.07 and 20.41; they reveal a concordance which confirms amply the one obtained under the above tests.

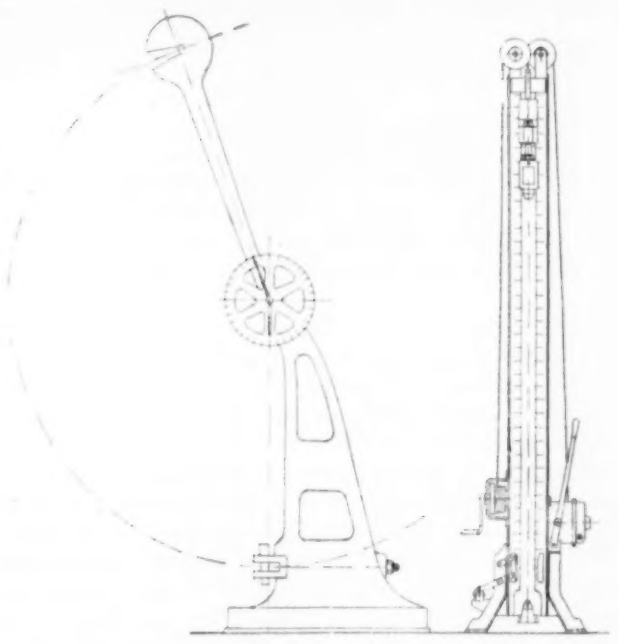


Fig. 6.

Sketch of the pendulum and of the drop hammer used to study the similarity between those two types of apparatus.
On the left is the 307 kg-m. pendulum; weight of the striking mass, 96.25 kg.; drop height, 3.87 m.
On the right is the drop banner; weight of the striking mass, 18.28 kg.; drop height, 3.05 m.
The concordance of the results obtained with this apparatus is satisfactory.

Having thus established the practical identity of the results obtained by impact by two apparatus of the same type, yet differing greatly from each other in dimension, we proposed to ascertain if the various types of usual apparatus were comparable.

Pendulum vs. Drop Hammer.—Our first experiments were on a pendulum and a drop-hammer (Fig. 6); it was natural to investigate the qualitative similarity.

To that end we made a group of $4n$ uniform bars and determined the mean resiliency of the lot by breaking $2n$ of them with a pendulum. Let $T_m \pm 2$ per cent be the mean work to break each of these bars. We then computed the height H from which we had to drop mass P of the hammer so that

$$PH = T_m$$

This being solved, we let the mass P drop: 1st—From a height 0.90 H, upon n of the remaining bars. None of them were broken. 2nd—From a height 1.10 H upon the remaining bars. They were all broken. We tested in succession a hammer weighing $p = 18$ kg. and one weighing 75 kg.; in both cases these results held in spite of the variation in weight of the mass and the height of fall.

Qualitatively then, the pendulum and the drop hammer are consistent; this degree of similarity had now to be computed. To that end, we placed an Amsler-Laffon register upon the drop hammer which precisely determines the velocity both before and after break, and furnishes data with which to compute the work of fracture. The bars were of the Copenhagen type, 30 x 30 x 160. The distance between the supports was 120 mm. for both apparatus.

Table XII sums up the results obtained.

The two mean resiliencies differ from each other by only 0.74 kg-m., that is: 7.1 per cent of the higher figure.

TABLE XII

Type of Apparatus	Height of Drop, m.	Hammer Weight, kg.	Mark on Bars	Individual Resiliency	R_m	e_m	E_m	Extreme Values
Pendulum	3.87	96.25	P II	1 10.44 2 10.44 3 10.44 4 10.44 5 10.19	10.39	±0.08	0.7%	10.44–10.19
Drop hammer	3.05	18.28	P II	6 9.95 7 9.20 8 9.67 9 9.52 10 9.91	9.65	±0.23	2.4%	9.95–9.20

Considering the crude arrangements made in setting up the register and putting up the hammer and its supports, the indications of the two are in very satisfactory agreement

Pendulum vs. Rotating Block.—Experiments made at the National Conservatory of Arts and Industry have used Charpy 300 to 30 kg-m. pendulums, Guillery vertical and rotative blocks of 275 and 60 kg-m. We do not need to emphasize again the results of the comparison between pendulums and drop hammers and which have only confirmed the results previously presented. But we deem it our duty to call attention to the comparative tests made upon the Guillery and Charpy apparatus, the indications of which were practically identical in spite of the essential difference in principle which characterizes the two types of instruments (Fig. 7).

Table XIII sums up these experiments.

TABLE XIII

Apparatus	Material	Impact Velocity	Mean Resilience	Mean Error	Mean Relative Error	Extreme Values
30 kg-m. Charpy pendulum	J_{10}	5.519 m.	18.55	±0.25	1.3%	19.01–18.24
60 kg-m. Guillery rotator	J_{10}	8.858 m.	18.4	±0.34	1.9%	18.9 –18.0
300 kg-m. Charpy pendulum	J_{30}	9.637 m.	18.78	±0.45	2.4%	19.64–18.21
275 kg-m. Guillery rotator	J_{30}	8.858 m.	20.45	±0.71	3.5%	21.78–19.78

J_{10}
Metal: J
5 Bars: 10x10x53.3
Round notch, 0.7 mm.
Supports at 40 mm.

J_{30}
Metal: J
5 Bars: 30x30x160
Copenhagen notch
Supports at 120 mm.

Here again we notice that the comparison between these two types of apparatus is very satisfactory. The computed results would be still nearer if the calculations were made in the same way in both cases. However, the mathematical attachments of the Guillery blocks do not duly take account of the power absorbed by the velocity of the fragments after the break, while those of Charpy pendulum subtracts that energy.

Hence we may conclude that the resiliencies obtained upon a uniform bar are practically identical, whatever may be the height of drop or the weights of the striking mass and the anvil block, or the type of apparatus employed, (within the limits of current practice). To make uniform impact tests on a single bar, it suffices to fix a few material requisites a priori and arbitrarily such as the distances between supports, the shape of the rounded off parts of the supports and those of the head-knives.

Influence of the Type of Notch.—The tests previously expounded were performed upon bars of the Copenhagen type, or their immediate relatives shown below:

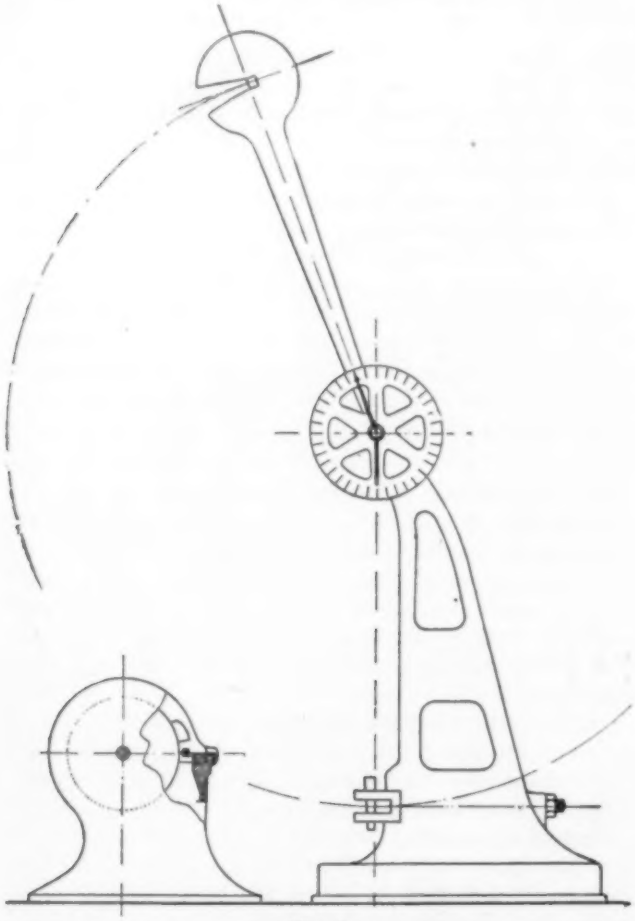


Fig. 7.

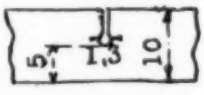
Diagram of the Guillery rotating block and of the Charpy pendulum used to compare these two types.

On the right the 300 kg-m. pendulum.

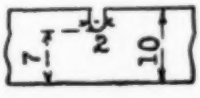
On the left the rotating block of 275 kg-m.

Not only the shapes and dimensions of the instruments, but also the principle are very sharply contrasted. In spite of that, the resiliencies obtained are perfectly consistent.

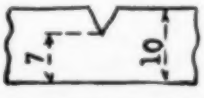
Table XIV



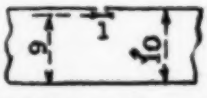
Round notch A; remaining section $10 \times 5 = 0.5$ cm². Drilled and cut with saw.



Round notch B; remaining section $10 \times 7 = 0.7$ cm². Drilled and cut with saw.



Sharp notch C; remaining section $10 \times 7 = 0.7$ cm² milled.



Square notch D, remaining section $10 \times 9 = 0.9$ cm². Made with old saw.

The shape and dimensions of the notch not having yet been standardized, it is necessary to determine the influence of the nicking on the rupture-work per square centimeter.

TABLE XV

Kind of Metal	Notch	Rupture Work, kg-m	Resiliency,	R_m	e_m	E_m	Extreme Values
Medium carbon steel "E"	A	7.363 7.243 7.604 7.725 7.483	14.72 14.49 15.20 15.45 14.96	14.96	±0.28	1.9%	15.45-14.49
	B	16.254 16.120 16.656 16.522 16.120	23.22 23.02 23.79 23.60 23.02	23.33	±0.29	1.2%	23.79-23.02
	D	Not broken	>33	>33	±0.29	1.2%	23.79-23.02
Medium nickel steel "J"	A	6.080 6.308 6.308 6.538 5.967	12.16 12.62 12.62 13.07 11.93	12.48	±0.34	2.7%	13.07-11.93
	B	11.157 11.421 11.189 11.952 12.085	15.93 16.31 16.88 17.07 17.26	16.69	±0.45	2.7%	17.26-15.93
	C	9.342 9.088 9.088 9.215 9.469	13.34 12.98 12.98 13.16 13.52	13.19	±0.18	1.4%	13.52-12.98
	D	20.545 20.792 20.296 20.045 19.025	22.82 23.10 22.55 22.27 21.13	22.37	±0.53	2.4%	23.10-21.13
Medium Cr-Ni-Steel "P"	A	2.567 2.313 2.313 2.397 2.313	5.13 4.63 4.63 4.79 4.63	4.76	±0.15	3.3%	5.13- 4.63
	B	3.954 4.054 4.054 3.954 3.954	5.64 5.79 5.79 5.64 5.64	5.70	±0.07	1.2%	5.79- 5.64
	C	2.481 2.313 2.230 2.313 2.313	3.54 3.30 3.18 3.30 3.30	3.32	±0.08	2.5%	3.54- 3.18
	D	5.304 4.875 4.665 4.770 4.561	5.89 5.41 5.18 5.30 5.06	5.36	±0.22	4.2%	5.89- 5.06

To determine this we experimented on 10 x 10 x 53.3 bars and adopted the four types of notching as shown. Table XV summarizes the results obtained upon a 30 kg-m. pendulum which establishes the following points (sharp notches not being included).

In reference to unbroken pieces, the resiliency increases as the depth of the notch lessens; it even doubles in very resilient steels when we pass from the notch half through the piece to that only 1 mm. deep.

The resiliency varies but very little with the depth of the notch in fragile metals.

If we consider the sharp notch, it will be seen that: In unbroken bars, it gives results analogous to those of a deeper round notch, and it gives lower results with brittle metals.

These experiments, confirmed by the determinations made at the Conservatory of Arts and Industry, establish the importance of precision in notching. They reveal how certain experimenters have come to the conclusion that the relation between fractured area and original area is immaterial for brittle metals. They show, moreover, how other metallurgists using shallow notches exclusively attribute resiliencies to ordinary metals greatly exceeding those which are generally attributed to steels of the same grade.

It is indispensable to employ only standardized types of bars—from a scientific standpoint to permit comparison between experiments made in different laboratories; from a practical standpoint to be able, if necessary, to take notes of precise meaning.

Most experimenters agree in admitting that notching must be geometrically defined; its depth and radius would then remain to be arbitrarily fixed. From the results shown above and considering the advantage of the rigorous localization in the break, it is evident that preference be given to deep notching. The influence of the radius of the cylindrical cavity appears to be quite secondary.

Influence of the Dimensions of the Bars.—It would be evidently desirable to be able to adopt a standard bar, but this runs against real difficulties in practice.

Under such conditions it is proper to ask if there is a simple relation between resiliencies determined upon bars of the same metal but of various shapes. It has been presumed from the first that it would suffice to have notched test pieces similar geometrically to secure comparable results. Tables Nos. VII and VIII clearly weaken that interpretation and reveal that the resiliency in one and the same metal varies considerably if it is determined with bars 30 x 30 x 160, or with smaller bars, 10 x 10 x 53.3. Variation is always produced in the same direction, whether it be steel or copper, the resiliency increasing with the dimensions of the bar. The ratio is not constant, changing from 3:2 for the toughest steel to 4:2 for the most fragile steel, and to 5:2 for copper. These facts have been recognized before by numerous authors experimenting independently, as may be inferred from the report presented by one of us at the New York Congress in 1912.[6]

A theoretical study published in 1911 by Captain Mimey,[7] led to the conclusion that the deflections B_1 and B_2, whether in notched bars or straight bars, if of a proportional ratio devoted by "a" would absorb an amount of work T_1 and T_2, varying as the cubes of the corresponding dimensions, if the striking masses M_1 and M_2, the heights of drop H_1 and H_2, and the distances of the supports D_1 and D_2 were as

$$\frac{M_1}{M_2} = \sqrt{\frac{H_1}{H_2}} = \frac{D_1}{D_2} = a$$

Unfortunately our experiments seem to show that this relation, attractive in its simplicity, is not acceptable to the demands of practice. In the course of our paper we have indeed brought out the fact that the work absorbed in breaking a bar is independent both of the weight of the striking mass and of the height of drop. In other words, the work absorbed is practically independent of the available energy and of the velocity of the block at the moment of impact. The additional conditions given by Captain Mimey do not consequently suffice, *a priori*, to compare the resiliencies obtained with two similar test pieces. We have verified it repeatedly, but will confine ourselves to presenting two of the determinations: one upon copper and the other upon the special steel *P*. These two metals were selected to assure the highest possible homogeneity in the inner structure.

The experiments were conducted in the following manner: We had two geometrically similar pendulums with masses of 96.250 kg. and 32.140 respectively. To have these operate similarly it sufficed that the pendulum

[6] Georges Charpy.—Report upon Impact Tests, and the Activities of Commission 26. New York Congress (1912). International Association for Testing Materials, IV (p. 3 e.s.).

[7] "Remarks upon Impact Tests" Revue d'artillerie (July, 1911).

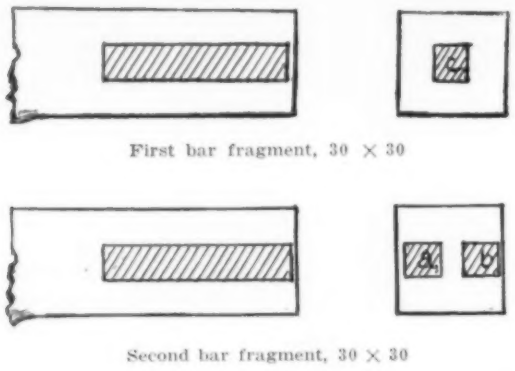


Fig. 8. Method of cutting 10 × 10 × 53.3 bars from 30 × 30 × 160 fragments

have a free fall of 160 deg. and the second a free fall of 58 deg.

Five 30 x 30 x 160 bars (cylindrical notch 4 mm. diameter at center) were then broken by a fall of 160 deg., establishing a series of equal resiliency. Then pieces of two bars of this series were selected at random, from which were cut six small bars, 10 x 10 x 53.3 (cylindrical notching of 1.3 mm. in diameter at center), according to the sketch, Fig. 8.

TABLE XVI

Metal	Test Bars		Resiliency	Mean Resiliency	Mean Error	Mean Relative Error	Extreme Results
	Size	Marks					
Copper	30x30x160	Cu I: 1	12.35	12.14	±0.27	2.2%	12.61–11.83
		2	12.09				
		3	11.83				
		4	12.61				
		5	11.83				
	10x10x53.3	Cu I: 2—a	5.41				
		b	4.76				
		c	4.76				
		Cu I: 3—a	4.76	4.87	±0.18	3.7%	5.41–4.76
		b	4.76				
		c	4.76				
Steel "P"	30x30x160	P I: 1	9.94	9.55	±0.38	4.0%	9.94–9.46
		2	9.46				
		3	9.46				
		4	9.46				
		5	9.46				
	10x10x53.3	P I: 1—a	4.76				
		b	4.76				
		c	4.76				
		P I: 2—a	4.76	4.76	±0.0	0	4.76
		b	4.76				
		c	4.76				

These six small bars were then broken upon the small pendulum with a fall of 58 deg.

With these conditions the results obtained both upon copper and steel were as in Table XVI, which establishes:

1st.—That the metal is homogeneous, since the small bars a and b act identically as the small bar c.

2nd.—That the resiliencies given by the 10 x 10 bars are distinctly different from the resiliencies offered by the 30 x 30 bars.

Hence we are justified in saying that the law of similitude does not apply to notched impact tests.

The conclusions arrived at by Captain Mimey are applicable however when a deformation short of fracture is produced through impact on unnotched bars. Indeed the deformations are then affected solely by the volumes of the bars and may be to one another like the cube of the corresponding dimensions. But as one of us already observed[8]: If we reach the breaking point one must add the work corresponding to the separation of the two halves of the bar, a work which may be considered, as a first approximation, as being proportional to the square of homologous dimensions. It would be necessary then to use a formula of two terms as

$$a\,x^3 + b\,x^2$$

to account more accurately for the phenomena. However, tests undertaken for the purpose of verifying this interpretation have not yet given sufficiently clear results to come to a precise conclusion; they even seem to bring out the fact that the order of complexity in the relation sought is even superior to the formula.

Conclusions.—In the course of this study we have been led to seek a precision which naturally would have no *raison d'être* in practice; in most cases it suffices indeed to know whether a metal is fragile or no, and the knowledge of its resiliency, to a limit of 1 or 2 per cent matters little.

Yet it was desirable to establish groups of uniform determinations, so as to settle as definitely as possible a whole series of questions under debate for the past ten years.

In a general way, we believe we have demonstrated clearly that measurements of resiliency are capable of a precision analogous to that obtained with other current tests in metallurgical laboratories such as tensile, hardness, etc.

We have shown also that impact tests upon notching do not offer any direct correlation with the other ordinary tests, and are infinitely more sensitive to the influence of certain details in the working of metals. It seems entirely probable even if it is not wholly established, that these influences act equally upon the way in which steel performs in service, but even if not, it is assuredly unwise to neglect the mode of investigation which reveals them.

Having a homogeneous material to work upon we were enabled to study with assurance the influence of the various factors within the impact test. Hence we succeeded in drawing a series of conclusions which may be briefly laid down as follows:

1st.—The apparatus used by us for the impact of different types (vertical blocks, pendulum-blocks and rotative blocks) and of different dimensions give practically identical resilience, if the distance between supports and the radii of the rounded off parts coming in contact with the bar during the test be made the same. For those rounded off parts we have adopted a radius equal to that of the cylindrical portion of the Copenhagen notch made upon the corresponding bar (that is $r = 2$ mm. for 30 x 30 bars and 0.66 mm. for 10 x 10 bars. Moreover, we discovered that it was necessary to provide very careful machining and maintenance. To obtain comparable results it is not necessary to fix *a priori* a type of testing machine; it suffices to operate a well-constructed, well-graduated apparatus of any size comprised within ordinary limits. The agreement between the graduations between any two given instruments and the standardization of an instrument with itself, can be numerically computed by a calibration test, which is a simple bending test on an unnotched bar.

2nd.—The numerical value of the resiliency can only be interpreted when we indicate at the same time the shape and dimensions of the bar and the notch. No law is yet known for the computation of the resiliency of bars of differing dimensions.

[8] G. Charpy—On an experiment upon metals by the bending of notched bars. Records of the Society of Civil Engineers of France (October, 1914).

Finally one may ask: What is the practical value of these tests? We propose to consider this question further, but it is too intricate to be treated casually. At present we only state the problem while emphasizing its importance, as great for the producer as for the consumer.

Packing and Plant Handling of Hazardous Chemicals*

By N. A. Laury†

Many have sought for a safe and economical package for the transport of the convenient quantity of one or two hundred pounds of acid or other corrosive liquid, but nothing has yet been suggested that equals the standard form of wood-packed glass carboy for general use. This has weak points and is the cause of some accidents, but if the requirements of the Interstate Commerce Commission as to quality of material and construction and testing are faithfully followed and certain precautions in handling are taken, the present package can serve at least safely until the arrival of a more practical substitute.

The mechanical appliances in use for handling carboys are nearly all economical and much safer than the simple picking up of the carboy by one or two men when a loose stopper or defective box may cause injury. The successful use of conveyors, roller skids, derricks with ice-tong grips or the various forms of trucks depends on plant arrangements and the intelligence of the workmen. Two sticks passed under the side cleats and handled by two men may, at times, be the cheapest way and all are safer than direct handling. Full carboys should never be moved unstoppered. If nothing else is available, an inverted tin can may prevent dangerous splashing.

The use of compressed air to empty glass carboys is dangerous. The bottles often burst or some acid is invariably left to be returned in a supposedly empty package. Tnis has caused many accidents, and as it is also to the consumer's advantage to keep all of the contents, he should see that returned empties are thoroughly drained. It appears that otherwise the Interstate Commerce Commission will require that empty carboys be washed before shipment.

Breakage of carboys is sometimes caused by partial crystallization of the contents. For example, sulphuric acid of strengths between 60 and 66 deg. Bé. and glacial acetic acid easily freeze and may on warming contain part of the acid, as a large floating solid mass which easily breaks the bottle unless it is handled with unusual care or first thoroughly thawed out.

The use of hand hooks is a quick and safe way for men on a platform or the tail of a truck to receive carboys handed to them from the ground, but by far the safest manner of raising carboys a short distance is by roller skid.

There is in current use a stoneware stopper and plaster of paris tied down with cloth, the latter sometimes coated with tar or paraffin. If the plaster is mixed in small quantities and applied fresh, it holds so solid that one may move the carboy about by the stopper, but in a few days the acid loosens the grip of the plaster and the cloth, even when treated, in time crumbles away. The safest practicable stopper in use consists of a glass or stoneware plate held on by a wire clip like a fruit jar. The joint is made tight by grinding the upper surface of the lip and using a tar paper asbestos or rubber gasket according to the acid shipped. The best form of clip is that in which the wire ends grip into holes in the sides of the bottle neck. These holes may be molded in new bottles or ground into old ones.

Carriers forbid the return of empties unstoppered. Customers therefore return empties loosely stoppered and vibration of the stopper in transit chips the bottle necks so that many cannot be refilled and some that are refilled prove a risk. This cannot happen with the fruit-jar style of stopper.

The familiar form of hand truck in use at freight stations does very well for barrels, but if a carboy with an old-style stopper is picked up with it the bottle must rest on its side while the truck is laid down to be unloaded. Leaks are thus often started with bad results. The fruit-jar form of stopper is proof against this risk.

Of course, the latter stopper is a hermetical seal and the bottle is under a pressure which depends on the temperature and the air space left in the bottle. A carboy filled outside in winter and thus sealed may develop a dangerous pressure if stored in a warm warehouse, but a 10 per cent air space safely covers even this extreme.

The greatest danger in the handling of carboys is the sudden giving away of the bottom or sides of the box due to the corrosion of the nails or weakening of the wood by acid, especially after long storage. This danger can be just about eliminated by the use of wood preservative.

It has been observed at one plant for some years that carboy boxes last two years under normal conditions. During this period the box has to be renailed three times and requires one new bottom and one new cover. Somewhat over two years ago several hundred boxes were treated with different preservatives and put into service along with some untreated boxes and records kept of their repairs. The treatment consisted of merely dipping the new box in the cold preservative.

It was found that all the preservatives tried made the boxes wear better. The materials used were ordinary coal tar creosote at 25 cents a gallon, avenarius carbolineum at 80 cents a gallon, S. A. wood preserver at 60 cents a gallon, and Preservol at 50 cents a gallon. The latter proved to be the best, as it dried in a few minutes and left a waterproof coating on the surface of the wood, while the others were deeply absorbed.

The carboys treated two years ago are still in service, and very few of them have required renailing and none have had new covers or bottoms. This is due as much to the protection of the nails from rust as to the protection of the wood from acid. These treated carboys should easily last two years longer.

All of the above applies largely to the standard lead carboy for the transport of hydrofluoric acid. Steel drums are used for this purpose in Europe, and are said to be safer and cheaper, but they are not yet accepted for rail shipments in this country.

*A paper read at the New York Meeting of The National Safety Council.

†Supt. Camden and Easton Works, General Chemical Co.

The lead carboy is subject to a pressure test prescribed by the Interstate Commerce Commission before each filling, and it must also come up to other requirements as to material and construction, and if properly handled it is safe if not economical.

These carboys sometimes burst due to high pressures which are unexplainable under the normal conditions of their use. The cause has often been traced to the presence of foreign matter. It is a package that is particularly hard to wash, and if a consumer puts it to other use in his plant and returns it uncleaned it may pass the usual washing before filling and still retain all the foreign matter necessary to generate a bursting pressure.

Owing to the very serious nature of hydrofluoric acid burns, both rubber stoppers should be replaced and the cap securely hooked down before returning empties. When a carboy is received with a leak, it should be thoroughly washed inside and out before returning.

The names of makers of materials recommended may be obtained from the author at River Road, Camden, N. J.

River Road, Camden, N. J.

Training Course of the American Steel & Wire Company

By Chas. R. Sturdevant

Educational Director, A. S. & W. Co.

No arguments are needed in these days to show why salesmen or other men holding responsible positions should, in some manner, be given special training and be encouraged to become the very best of which they are capable. This principle has become so thoroughly recognized and so firmly established that to-day hundreds of our leading business and industrial concerns either have well established courses, or are casting about to discover some effective way of training those employees holding responsible positions.

With concerns housed in one building, or a single group of buildings, the problem is a comparatively simple one, for the men to be trained can be brought together once or twice a year, having them confer with the several department heads, listen to lectures, and make inspection trips through the mills. But when the mills are widely scattered, and when widely differing products are made in them, the problem becomes a difficult one.

The American Steel & Wire Company has mills and offices located at Chicago, Cleveland, Pittsburgh, Worcester and other cities. It employs many thousands of men and women, and makes a wide variety of wire products, both steel and copper. As the business expanded and the company grew, there developed an insistent need of some thorough, systematic method of training its employees in matters pertaining to the steel and wire business. Such a course was instituted in 1912, and it has met with such success that a description of the work will be of general interest.

As originally organized the course was intended for veteran salesmen only, but shortly afterwards it was found advisable to slightly modify the course and make it suitable for men from other departments as well. The course is intended only for employees who have been in our employ for a considerable period—not for beginners. It is carried on under the immediate supervision of three competent instructors taken from the organization, and requires practically all of their time. The class spends one week in the Pittsburgh district, three in the Cleveland district and two and one-half at Worcester, Mass. To complete the course thus requires six and one-half weeks of intensive study and application on the part of the men. All traveling expenses are paid by the company, and a daily allowance is made for living expenses while engaged in the course of study.

The work has been handled in successive classes of about twelve men each, and seven classes have taken the course each year. The twelve men constituting a class are purposely chosen from different parts of the United States, and from different departments. Ordinarily there will be about two men from the operating department, one from the accounting, one from the order department, and eight from the sales department. In general these men will differ widely in age, experience and capabilities. The close association, for six and one-half weeks, of such a diversified group of men, is in itself a liberal education.

The men selected for a given class are given two or three weeks' previous notice, and are, at the same time, assigned suitable preparatory reading matter. At the appointed time they assemble at Pittsburgh, Pa., where they will first meet an instructor who will organize them into a class, and who will remain their instructor and guide during the succeeding four weeks.

Nearly all of the first week is taken up in making inspection trips through various steel and wire mills in the Pittsburgh district. This affords the men an opportunity of obtaining a general idea of how all our products are made and of the work to be taken up in the course, and also stimulates a strong desire to go thoroughly into details.

During the second week the class studies steel making. From step to step they learn how the ore is converted into pig iron, how this is converted into the several grades of steel, and finally how the steel ingot is made into a rod. During the following week they are taught how the various grades and kinds of wire are made from rods. They become familiarized with our so-called "common products," and with the processes of manufacture. During the balance of the course they are shown and taught how this wire is given special treatments in order to impart desired properties; how the wire is tested, and how it is fabricated into the various common or special commodities made by the company, such as woven wire fencing, wire nails, wire rope, electrical wires and cables and so on.

The real work of the course, it will be observed, begins with the second week, after the men have become well acquainted with their fellows, and with the work to be covered. Each day's work from then on (except on Saturdays) is divided into four periods; a forenoon mill inspection trip, a noon-day lecture and discussion, an afternoon quiz and evening study.

Each morning the class, under the guidance of an instructor and one or two mill-foremen, is taken slowly through some one mill where they can witness every detail of the process involved in the making of some one product or some closely related group of products about which they studied the evening before. In this manner the men are given every opportunity of making a detailed study of all essential materials, processes and

mill equipments. This systematic method of making mill inspection trips is very much more effective than the old way of sending them alone into the mills to wander about aimlessly.

Just before or after the mid-day lunch, the mill superintendent or department expert will carefully review the morning's work, and afford the men an opportunity of asking questions and entering into a general discussion. During the latter part of each afternoon, an instructor subjects the members of the class to a searching quiz, which helps greatly to organize the knowledge of the day's work, and to fix it in their minds. This quiz also enables the instructor to determine very quickly the points which need to be especially emphasized, and it soon indicates to him the particular men who need personal help. It further gives each man an opportunity of measuring himself with others who have had the same opportunities, and it is a strong agency to spur him on to his best efforts.

At the close of the quiz, a small, specially prepared booklet is given to each man covering the following day's work, and the men are requested to study this thoroughly during the evening. It will be seen that the course is laid out on the budget system—a full day being devoted to some one subject, and the various subjects are of course taken up in logical order from day to day, proceeding naturally from the simple to the more complex.

On several occasions, the class is given regular set lectures by department heads. These are not only enjoyable diversions, but they serve to bring the whole personnel of the company into closer touch and sympathy.

Five written examinations are given, usually on Saturday mornings, and at the close of the course one whole day is devoted to a general oral review. These examinations are carefully reviewed and graded, and they help to make up the final report of each man, copies of which are sent to those of our company who are directly interested.

While it is an intensive course of study, the work has been so laid out and is so handled as to require a minimum amount of time and effort on the part of the student. And while a great majority of the men are wholly unused to study or to close application at the time they enter the course, in spite of these seeming handicaps, they do acquire a surprising amount of useful knowledge even in so short a period as six and one-half weeks.

As to the resulting benefits both to the men and to the company, there are many. Aside from the direct result of a greatly increased useful knowledge of the technique of the business, they learn to think straight in the conception and application of fundamentals; they are given a broadened viewpoint and a quickened interest in their work. This free exchange of views acquaints many for the first time with the difficulties which men in other departments have to overcome, and this encourages them to better team work and makes them less critical. The course stimulates self-confidence, loyalty and good fellowship. The one great regret of the older men who have taken this course is that they were not given the opportunity earlier in life, which, in itself, is ample justification of the effort put forward in their behalf.

Worcester, Mass.

On the Superheating of Slags and Metals During Refining, Smelting and Alloying Operations*

BY J. E. FLETCHER, M.I.MECH.E.†

In the production of wrought iron and steel or ingot iron in the open-hearth furnace, it is becoming clearer that the mechanism of refining and alloying is that of the intimate reactions which occur between the various constituents of the pig iron, ore, and scrap charged and those of the slags used in the efficient carrying out of such processes.

The finished cold cast products are crystalline composite masses made up of more or less carbonized or otherwise alloyed crystals separated from each other by boundaries which probably always contain minute particles or films of isolating matter. It is known that such films often contain the iron oxides FeO and Fe_2O_3 together with silicates of iron and manganese. There is further evidence that occluded gases in a fine state of division occur within the crystal boundaries. Such films must tend towards the non-welding of the adjacent crystal faces when the molten or liquido-plastic crystals are being drawn together in their passage to the solid state.

The high temperatures needed in the ferrous alloy processes make the study of the reactions and of the constitutional changes in both slags and alloys exceedingly difficult; there is a sense, however, in which it may be said that the reactions at high temperatures are more simple than at lower ones. Thus M. Charpy succeeded in cementing or carbonizing iron filings by heating at 650 deg. C. for about forty hours in potassium cyanide, the alloy produced being the iron carbon eutectic containing 4.3 per cent carbon and melting at about 1130 deg. to 1135 deg. C. Similarly after heating for eighty-five hours the alloy containing 6.67 per cent carbon and 93.33 per cent iron (Fe_3C) was produced. With only three hours' heating at 1130 deg. C. the 4.3 per cent carbon eutectic alloy resulted. Moissan, at the temperature of the electric arc, succeeded in carbonizing iron to a content of about 4 per cent in three minutes, and the author, in a like period, also at the temperature of the electric arc, obtained an alloy containing 5.5 per cent carbon. Later Ruff and Goecke produced a 9.6 per cent carbon iron alloy by cementation in an electric furnace at 2220 deg. C., the time required at this high temperature being relatively short. These experimenters concluded that there is a progressive formation of the carbides Fe_3C, Fe_2C, and FeC at increasing temperatures until at about 2700 deg. C. gasification of the alloy (FeC + Fe) takes place.

SLAGS IN GENERAL

The refining and alloying slags in iron and steel processes may be divided into three types, viz., those whose temperatures of formation, fusion, and equilibrium are (1) higher, (2) approximately the same, and (3) lower than the fusion and equilibrium of the metallic alloys in contact with the slags.

The slags of type one are representative of blast-furnace working, where the pig-iron fusion temperatures are in the neighborhood of 1140 deg. C. Such slags have the composition:

*A paper presented before the 1917 meeting of the Society of Chemical Industry, Birmingham, England.

†President, Staffordshire Iron and Steel Institute.

$CaO + MgO + FeO + MnO$ = 50 to 55 per cent,
$SiO_2 + Al_2O_3 + P_2O_5$ = 45 to 50 per cent,

the fusion temperatures of which are in the region of 1400 deg. C.

The slags of type two are typical of the puddling process where the fusion and softening temperatures of the metal being operated upon vary from 1130 deg. to 1450 deg. C., the slags having fusion temperatures varying between 1080 deg. C. and 1350 deg. C. and are silicates of iron and manganese of the approximate analysis:

$FeO + Fe_2O_3 + MnO$ = 70 to 80 per cent,
SiO_2 = 20 to 30 per cent.

The slags of type three are representative of the open-hearth steel melting processes. Here the metal fusion temperatures vary from 1130 deg. to 1500 deg. C., whilst the slags fuse at between 1100 deg. C. and 1350 deg. C. and have the typical analysis:

For the acid process:

$CaO + MgO + FeO + MnO$ = 40 to 50 per cent.
$SiO_2 + Al_2O_3$ = 50 to 60 per cent.

For the basic process:

$CaO + MgO + FeO + MnO$ = 80 to 70 per cent.
$SiO_2 + P_2O_5$ = 20 to 30 per cent.

Now obviously the temperatures of refining, smelting, and alloying hearths of the furnaces must be kept higher than those of the slags or metals under treatment. Hence in case one the blast-furnace metal is superheated above its fusion point; in case two the puddled iron and slags may be kept nearly at their proper fusion temperatures; and in case three the slags are superheated above their fusion temperatures.

BLAST-FURNACE SLAGS

Here the slag fusion temperature is higher than that of the contact metal. The temperatures of the tuyere zone are in the region of 1500 deg. C., the slag fusion temperatures being between 1350 deg. C. and 1450 deg. C., while the underlying metal is melted at roughly 1140 deg. C. The slag and metal are therefore continuously superheated above their fusion temperatures. The metal in the hearth is primarily of eutectic composition or thereabouts, viz., 4.3 per cent carbon, 95.7 per cent iron. The result of superheating this eutectic is first to render the contained carbide of iron (Fe_3C) unstable. The higher it is heated above its melting point, 1130 to 1135 deg. C., the greater is this instability apparent and its sensitiveness to refining or alloying action increased. Similarly the oxide constituents of the slag which are reducible at the hearth temperatures become unstable under conditions of superheat, the silica, SiO_2, and phosphate of lime, $4CaOP_2O_5$, being readily reducible.

At the hearth temperatures, 1500 deg. to 1600 deg. C., the slag composition tends to adjust itself by parting with SiO_2 and P_2O_5 until it attains equilibrium consistent with the degree of superheat. If given sufficient time at, say, 1500 deg. C., an equilibrium corresponding to the slag composition 20 per cent Al_2O_3, 80 per cent CaO·MgO would arrive in the case of a smelting using a working slag of primary non-superheated analysis 30 per cent SiO_2, 15 per cent Al_2O_3, 55 per cent CaO·MgO. The 1500 deg. C. saturated slag would then be inert, there being no further reducible constituent present in the slag. The metal in contact with the slag would also have moved toward stable equilibrium, and it can be shown that in the case of ferro-silicon manufacture an alloy of composition,

C	0.5%
Si	9.3%
Fe	90.2%

would result when the slag becomes inert. The fusion temperature of resulting slag and metal would be about 1450 deg. C. (In this case phosphorus, sulphur, and manganese have been omitted for the sake of simplicity.)

It is impossible at present to state the composition which corresponds to the stable equilibria of slags at varying temperatures or of the metallic alloys in contact therewith, but it may be inferred from the foregoing that by proper adjustment of the primary slag composition it is possible by correct temperature control to regulate the alloying actions in the metal.

It is clear that the cast iron becomes alloyed with silicon and phosphorus at the expense of its carbon the more readily as the slag is superheated and hence free to act on a superheated metal (unstable) in contact with it. Figure 1 illustrates the changes in the composition and temperature of equilibrium during the progressive alloying of a white iron with silicon. The active and relatively inert conditions of the slag are indicated by the shaded area marked "superheat." The higher the superheat the more active the slag and the more unstable the metalloid compounds in the metal attacked.

There are, doubtless, cases where, as in certain pneumatic refining and smelting processes, the excess of oxygen leads to oxidation of the metal underlying the slag. Such oxides may there rise to the surface and enter the slag which under certain temperature conditions may become more active, increasing the slag superheat because of the addition of iron oxide to the slag and coincidently lowering its fusion point. Carbon in a pig-iron charge may thus be oxidized at the expense of iron oxides FeO and Fe_2O_3 in the slag, iron passing back into the metal; such action being coincident with or preceding the silicon or phosphorus transfer. Thus a blast-furnace slag may become rich in FeO, the resulting pig iron being white. Iron has then been reduced from the slag in preference to silicon, and the total carbon content of the pig iron is lower than in the case where a normal slag free from FeO has been employed.

PUDDLING SLAGS

In the puddling process the slags are of the type ($FeO·Fe_2O_3·SiO_2$) having temperatures of fusion and

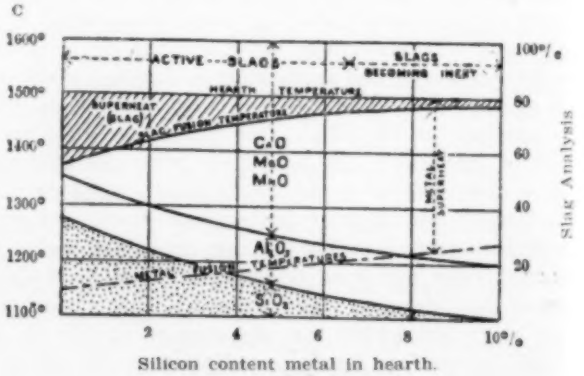


Fig. 1.
Equilibrium in Blast Furnace

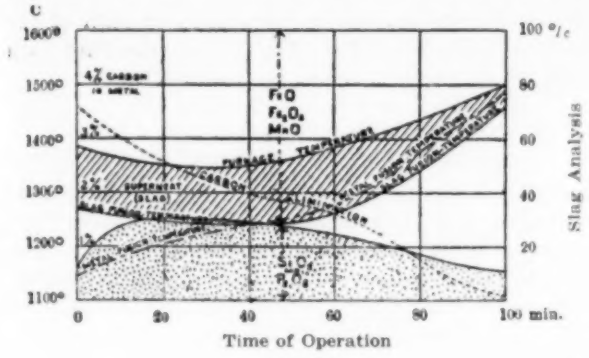


Fig. 2.

Equilibrium in Puddling Process

equilibrium not much different from those of the pig irons which it is desired to refine. Here it is necessary to desiliconize, dephosphorize, and decarburize the pig iron underlying or in contact with the slag. The initial fusion temperature of the pig iron to be refined is about 1140 deg. C., that of the first superposed slag being, say, 1260 deg. C. This slag is therefore superheated and consequently active. Unlike the blast-furnace slag the puddling slag is basic and continues so throughout the process. There is no deterrent or inert constituent such as lime or alumina, hence temperature variations rapidly alter the slag constituency. The active iron oxides in the slag attack the unstable iron phosphide and silicide in the pig iron and primarily furnish the oxide for gasifying the unstable carbon in the superheated iron carbon alloy, and for oxidizing the silicon and phosphorus which are also but feebly stable at temperatures above 1100 deg. C. There is an automatic adjustment of the slag composition throughout the process. At the beginning and end of the operation the temperatures are higher than during the intermediate stage. The initial and final slags are therefore high in $FeO \cdot Fe_2O_3$, and low in SiO_2, whereas in the intermediate stage the slag is more siliceous and more readily fusible. During "rash" or careless working the end of the operation is conducted at too high a temperature; hence the slag is too highly superheated and adjusts its composition by robbing the iron bath or sponge. The iron oxide thus added to the slag is largely the result of oxidation by the furnace gases (rich in O and CO_2). Figure 2 illustrates the foregoing actions. It is seen that the superheat is not so great as in the blast-furnace operation. Figure 3 shows the progress of refining and the coincident slag adjustment composition during the complete puddling process, and illustrates most clearly the effect of superheat on the slag and metal equilibria.

MANGANESE IN FURNACE SLAGS

In the production of certain alloy steel the effect of superheating the working slags results in the pronounced separating out of the most readily reduced slag constituent. Thus in the making of manganese steel in the open-hearth furnace the primary slag covering the molten pig-iron charge was a rich ferrous slag of the composition approximately $FeO \cdot Fe_2O_3 = 80$ per cent, $SiO_2 = 20$ per cent, fusible at about 1300 deg. C. Into this a pyrolusite ore of analysis

MnO_2	85%
CaO MgO	5%
SiO_2	10%

was gradually added. The MnO_2 becomes MnO on

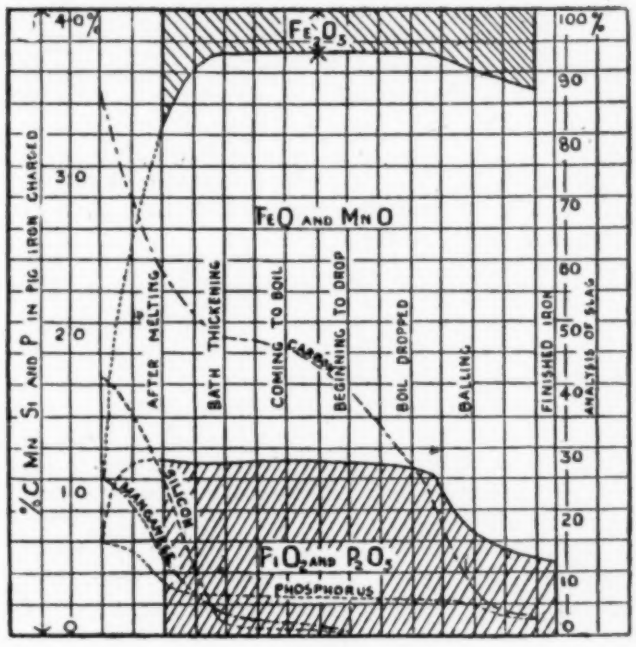


Fig. 3.

Effect of superheat on the slag and metal equilibria.

superheating, the FeO being changed to Fe_2O_3 by the oxygen liberated from the MnO_2. It was then found that the FeO and Fe_2O_3 in the slag, if increased by further additions of hematite ore (manganese) and lime, caused a rapid reduction of the manganese from the slag, manganese entering the liquid metal. When the slag contained over 50 per cent of manganese then that element entered the metal, whereas if the slag was adjusted so as to contain above 50 per cent of iron, then iron was reduced from the slag in preference to manganese. An increase in the superheat in either case increased the rapidity of the reduction. The temperature was not measured, but it was noticed that the slags higher in MnO were more fluid than the rich FeO-slags, and were apparently fusible at a lower temperature. Hence at the practically constant furnace temperature the high MnO-slags were more highly superheated than the high FeO-slags, hence more unstable, and then manganese in consequence more readily reduced.

The refining of alloys may be illustrated in the case of the elimination of manganese in the puddling or open-hearth steel processes. Thus the reaction between the slag constituent $FeO \cdot Fe_2O_3$ and the alloy constituent Mn_3C in the pig iron is of the type:

$$FeO \cdot Fe_2O_3 + Mn_3C = 3MnO + CO + 3Fe.$$

Manganous oxide displaces the iron oxides in the slag, the manganese in the pig iron being replaced by pure iron from the reduction of the iron oxides. Superheating the slag renders the $FeO \cdot Fe_2O_3$ more active, while that of the molten pig iron increases the instability of the Mn_3C. In the interaction CO gas is liberated. The slag is enriched by the entrance of MnO at the cost of the iron oxides $FeO \cdot Fe_2O_3$. Professor Turner's view that in such actions the active oxides $FeO \cdot Fe_2O_3$ are the reducing agents has been taken. They are in the state of least stability and hence in the condition to react with the other unstable compounds present when by superheat their stability is decreased. Possibly at the moment of exchange it is the ferrous oxide

which reacts with the Mn_3C in a reversible sense thus:

$$3FeO + Mn_3C \rightleftarrows 3MnO + Fe_3C.$$

Superheating the oxide FeO in an oxidizing atmosphere leads to the formation of Fe_2O_3 (as in the production of "bull-dog slag" by calcining puddling-furnace tap cinder). On the other hand, liquid Fe_2O_3 when in contact with molten iron-alloys is readily converted to FeO providing a reducing or neutral atmosphere is maintained in the working chamber.

ALLOYING A METALLIC MASS UNDERLYING A RICH SLAG

In siliconizing the white eutectic iron in the hearth of the blast furnace the SiO_2 in the slag interacts with the Fe_3C in the carburized white iron:

$$SiO_2 + 2Fe_3C = Fe_2Si + 4Fe + 2CO.$$

The carbide of iron in the eutectic metal is displaced by silicide of iron and pure iron is coincidently set free. CO gas is liberated and the slag is impoverished by the loss of the silica SiO_2. This exchange is affected by the superheating of the slag, the silicate of lime or magnesia therein becoming unstable. The interaction between the SiO_2 and the unstable superheated Fe_3C is thereby promoted as shown.

LIBERATION OF OCCLUDED GASES

When cast iron is heated considerably above its melting point the occluded gases, which are not inconsiderable in quantity, and consist mainly of CO and H, are set free. An examination of the microstructure of a pig iron which has been thus heated toward its boiling point reveals particles of silica surounded by an envelope of ferrite together with flakes of coarse graphite. It would appear that a reaction has taken place in this case between the escaping CO gas and the silicide of iron Fe_2Si, thus:

$$Fe_2Si + 2CO = SiO_2 + 2Fe + 2C.$$

The slaggy particles appearing in the microstructure are probably a silicate of iron formed according to the reaction:

$$Fe_2Si + 3CO = 2FeO{\cdot}SiO_2 + 3C.$$

In some cases such silicate slag rises to the surface of the metal which has been desiliconized to some extent by gaseous means. Again, sometimes iron oxide particles occur mechanically mixed and distributed throughout the cast-iron or steel mass as a result of over-oxidation or over-blowing in the hearth or bath of the furnace or converter. The effect of superheating such an alloy is to further refine the metal thus:

$$FeO{\cdot}Fe_2O_3 + 2Fe_2Si = 2SiO_2 + 7Fe,$$

$$\text{or } FeO{\cdot}Fe_2O_3 + Fe_2Si = 2FeO{\cdot}SiO_2 + 3Fe,$$

$$\text{and } FeO{\cdot}Fe_2O_3 + 4Fe_3C = 15Fe + 4CO.$$

H. Brearley has illustrated this action in his book on case-hardening, where a slag globule is shown surrounded by a ferrite envelope, and generally in iron and steel slag streaks are associated with adjacent ferrite.

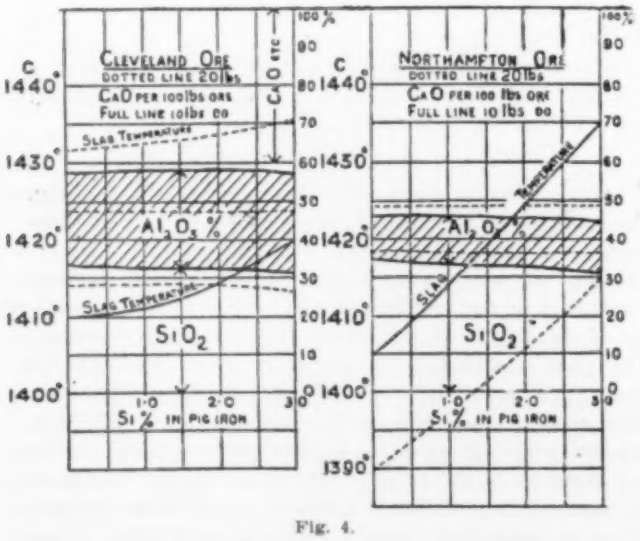


Fig. 4.

Automatic adjustment of a typical blast furnace slag.

MECHANISM OF REFINING

The mechanism of refining and alloying through the offices of the slags is shown in Tables I and II. In the blast furnace a portion of the carbon in the carbide Fe_3C is liberated in the CO gas formed and pure iron is freed to unite with the Si and P as silicide of iron Fe_2Si and phosphide of iron Fe_3P. These actions occur when the slag is superheated.

The automatic adjustment of a typical blast-furnace slag is shown in Figure 4, where, during the alloying of the iron in the blast-furnace hearth with silicon (the resulting pig irons having 0 to 3.0 per cent silicon) the slag composition alters thus:

	SiO_2	Al_2O_3	CaO MgO	Slag Softening Temp.
	Per Cent	Per Cent	Per Cent	Deg. C
Before alloying with Si	28.5	20.7	47.1	1435
With 1% Si in pig-iron	28.1	21.5	48.9	1440
With 2% Si in pig-iron	27.5	21.7	49.7	1440
With 3% Si in pig-iron	26.5	22.2	50.3	1445

As the slag adjusts itself during the loss of silicon the fusion temperatures of the slag are raised. Hence a higher hearth temperature and resulting slag and metal superheat become necessary as the more highly silicious pig irons are made.

Table 2 illustrates the mechanism of refining action in cupola, open-hearth, and puddling operations. Here the pig iron being refined is superheated above its melting point, the silicide, phosphide, and carbide of iron being thereby rendered unstable and react with the similarly unstable slag oxides (in this case the iron oxides). Silica and phosphoric acid escape to the slag and CO gas is liberated. The iron set free by the decomposition of the silicide, phosphide and carbide of iron and that added by deposition from the slag oxides, together with the primary iron crystals in the original pig iron (if containing less than 4.3 per cent carbon), yields a refined product more or less free from silicon, phosphorus, manganese and carbon.

IMPORTANCE OF SLAG-METAL CONTACT

It is evident from the foregoing that intimate contact between the metals and the slags in smelting, refining, and alloying operations is imperative if successful results are to follow.

In the blast furnace the reduction of the ores must be largely through gaseous (CO) influence. It is not possible for sufficiently uniform carbon (coke) contact with the oxide of iron (Fe_2O_3, etc.) particles to take place. The slag blanket which covers the metal in the hearth of the furnace is agitated by the splashing and penetration of the drops of liquid metal and slag as they descend from the upper portions of the tuyere

TABLE 1—BLAST FURNACE ALLOYING REACTIONS

	Superheated Unstable Constituents				Resulting Alloys in Metals				Constituent Ejected from Metal	
	In Slag	Lbs.	In Metal	Lbs.	Compound	Lbs.	Free	Lbs.	Compound	Lbs.
A.....	SiO_2	60	Fe_3C	340	Fe_3Si	140	Fe	224	CO	56
B.....	P_2O_5	142	Fe_3C	900	Fe_3P	398	Fe	504	CO	140
C.....	MnO (1)	213	Fe_3C	180	Mn_3C	177	—	—	FeO	216
D.....	FeO(2)	216	C	36	—	—	Fe	168	CO	84
					Reactions					
A.....	SiO_2	+	$2Fe_3C$	=	Fe_3Si	+	4Fe	+	2CO	—
B.....	P_2O_5	+	$5Fe_3C$	=	$2Fe_3P$	+	9Fe	+	5CO	—
C.....	MnO	+	Fe_3C	=	Mn_3C_2	—	—	+	3FeO	—
D.....	3FeO	+	3C	=	—	—	3Fe	+	3CO	—

TABLE 2—OPEN-HEARTH, PUDDLING AND CUPOLA REFINING REACTIONS

	Superheated Unstable Constituents				Result of Refining New Constituents Added				Compound Ejected	
	In Slag	Lbs.	In Metal	Lbs.	To Slag	Lbs.	To Metal	Lbs.	Compound	Lbs.
A.....	$FeO.Fe_2O_3$	232	Fe_3Si	280	SiO_2	120	Fe	392	—	—
B.....	$FeO.Fe_2O_3$	322	Mn_3C	177	MnO	213	Fe	168	CO	28
C.....	$FeO.Fe_2O_3$	464	Fe_3P	398	P_2O_5	42	Fe	504	—	—
					FeO	216				
					Reactions					
A.....	$FeO.Fe_2O_3$	+	$2Fe_3Si$	=	SiO_2	+	7Fe	—	—	—
B.....	$FeO.Fe_2O_3$	+	Mn_3C	=	3MnO	+	3Fe	+	CO	—
C.....	$2FeO.Fe_2O_3$	+	$2Fe_3P$	=	P_2O_5	+	9Fe	+	3FeO	—

zone. Hence there is a greater contact between slag and liquid metal than at first appears. The relationship between the area of slag contact and the iron smelted per hour is of practical importance. The ratio

$$\frac{\text{area of slag contact (sq. ft.)}}{\text{iron smelted per hour (tons)}}$$

is 15 to 25 in the case of modern hot-blast furnaces. In the days of cold-blast furnaces the ratio was as high as 40 sq. ft. of slag contact per ton of iron smelted per hour.

In the foundry cupola the ratio for modern furnaces is 0.7 to 1.0 sq. ft. per ton of iron melted per hour, and in the open-hearth steel-melting furnace the ratio

$$\frac{\text{area of slag contact}}{\text{metal refined per hour}}$$

is 20 to 30. In modern rapid practice in large furnaces the ratio is tending to increase, shallow baths and large area of slag contact being necessary for intensive outputs.

The more viscous and light the slag is the greater is the need for large contact area. During mechanical or natural agitation the heavier slags penetrate the metal surface in direct proportion to their density. In the heavy yet mobile puddling slags the rapidity of the refining action is readily explainable and the low viscosity combined with the continuous hand or mechanical rabbling promotes better contact between the metal and oxide particles.

It can be shown that in the alloying of silicon with iron through contact of the carbide of iron with the silica of the slag in the blast-furnace process the relative surfaces of contact of these two constituents are as 1:1.26 approximately, whereas in the decomposition of Fe_3Si in the refining operation of puddling the ratio of contact areas between Fe_3Si and the oxides $FeO \cdot Fe_2O_3$ is as 1:1. Hence it follows that more homogeneous interactions occur in the latter process. It is interesting to note that the ratio

$$\frac{\text{area of slag contact (sq. ft.)}}{\text{metal refined per hour (tons)}}$$

is about 50, twice that of the open-hearth steel process, the area of contact being sufficiently large to enable efficient washing and rabbling of the metal and slag to be carried out.

THE LIQUID CRYSTAL PHASE

Dr. Desch, in his recent invaluable contribution to the Institute of Metals, drew attention to the possible existence of a liquid crystal phase at temperatures higher than the fusion point of metallic alloys. In the study of ferrous alloys the observed variations in the viscosity of hyper-eutectic alloys when heated above their melting points, the decomposition of the carbide or carbides in carbon iron alloys as influenced by the presence of silicon, phosphorus, etc., resulting in a graphite-bearing viscous state, and the micro examination of such alloys when quenched from the superheated condition, all strengthen the view that above the liquidus curve of the phase diagram there may be a liquid crystal phase. It is difficult to determine such a phase and its temperature limits, but there is much to suggest that liquid iron crystals more or less carbonized and siliconized in ordinary cast irons and steels do exist, and that their carbonization and siliconization are effected more rapidly as the temperatures approach the purely liquid phase.

Taking the fusion points of iron and iron carbide Fe_3C as 1500 deg. C. and 1850 deg. C. respectively, it might be found that a line drawn between the two (possibly not a straight line, but a drooping curve) would be the frontier line between the purely liquid and the liquid crystal phases. In such a case the primary nuclei for crystal growth would occur within the liquid crystal phase and would not depend upon the freezing action in the now recognized solidus phase. Thus graphite may be precipitated in the liquid phase and act as the nucleus for the primary liquid crystals. Similarly silico-ferrite crystals may commence to form from the same or a higher temperature in the liquid phase and start a secondary ferrite liquid crystallization.

It is in such considerations that the difference between crucible melting (in a furnace with walls superheated above the temperature of the liquid crystal phase) and cold-hearth melting appears. Just as the steam bubbles in a boiler rise most strongly from the zones next to the heating surfaces, so the occluded gases and convection currents within a molten metal in a crucible rise most powerfully from the zones next to the heated walls. These details may have much to do with the fineness of crystalline structure in the final cast metal and with the homogeneity or heterogeneity of such structure. The fineness of such structure is related to the crystal boundary question, and to the freedom from gaseous or refining oxide and slaggy inclusions within such boundaries.

APPLICATION TO REFINING

It is instructive in this connection to trace the successive series of iron (liquid crystalline) deposition in the refining processes. In Table 3 the possible order of iron crystalline deposition is shown in three well-known variations of the open-hearth steel-making processes.

The first stage of the operation in each case is that of melting the charge. In the liquid thus formed are the primary crystals (melted or as liquid crystals) originally present in the pig-iron or steel scrap. The next iron addition to the bath is due to the decomposition of Fe_2Si, the Si entering the slag and liberating the iron of the silicide, coincidently there being added to the liquid mass free iron reduced from the iron oxides of the slag. Manganese carbide is next attacked by the slag oxides and MnO enters the slag, being displaced by pure iron reduced from the iron oxides in the slag. After this comes the carbon elimination, the carbide Fe_3C on decomposition yielding its Fe to the bath and simultaneously adding pure iron reduced from the iron oxides in the slag. Finally when iron ore (Fe_2O_3) in excess of purely refining requirements is added to the slag, further iron is reduced and makes the final contribution to the mass of refined metal. The analyses and estimates given in the table are only approximate, but are believed to offer a comparative view of the order of iron crystallization during refining in the three types of steel-making. Whether the iron increments are actually liquid crystals is as yet open to question.

TABLE 3

Analyses of Materials	C	Si	Mn	Fe	Fe_2O_3	SiO_2	S & P
	%	%	%	%	%	%	
Pig iron	3.8	1.5	0.8	93.9	—	—	Not estimated
Steel scrap	0.2	0.1	0.7	99.0	—	—	—
Ore	—	—	—	—	60 6	10.0	—

Pig and ore process—charge 75% pig, 25% ore.

(1) Primary crystals in pig iron ..... = 30.5 initially present in pig iron
(2) Iron crystals from Fe_2Si decomposition. = 4.3 refining of silico-ferrite.
Iron crystals from slag reduction..... = 3.3 refining of silico-ferrite
(3) Iron crystals from Mn_3C decomposition = 0.7 refining of eutectic
(4) Iron crystals from Fe_3C decomposition. = 40.0 refining of eutectic
Iron crystals from slag reduction..... = 9.6 refining of eutectic.
(5) Iron crystals from ore reduction ..... = 11.6 alloying by iron reduced from ore

Pig and scrap process—charge 50% pig, 50% steel scrap.

	Per Cent
(1) Primary crystals in pig iron	= 18.5
(2) Primary crystals in scrap iron	= 44.0
(3) Crystals from Fe_2Si decomposition	= 2.9
Crystals from slag reduction	= 1.9
(4) Crystals from Mn_3C decomposition	= 1.1
(5) Crystals from Fe_3C decomposition	= 25.6
Crystals from slag reduction	= 6.0

Pig, scrap and ore process—charge ⅓ of each.

	Per Cent
(1) Primary crystals in pig iron	= 14.6
(2) Primary crystals in scrap iron	= 34.5
(3) Crystals from Fe_2Si decomposition	= 2.4
Crystals from slag reduction	= 1.6
(4) Crystals from Mn_3C decomposition	= 0.8
(5) Crystals from Fe_3C decomposition	= 20.0
Crystals from slag reduction	= 4.9
(6) Crystals from ore refining	= 20.2

REFINED IRON STRUCTURES AND SUPERHEATING CONDITIONS

In the United States Mr. J. E. Johnson, Jr., the well-known blast-furnace expert, has produced a cast-iron which approximates in character to the finest of charcoal cold-blast iron such as is made in Sweden.

By adding a cast iron which has been partly refined in a Bessemer converter to an ordinary foundry iron molten from the blast furnace the following actions occur: The bessemerized metal low in carbon content and containing considerable quantities of occluded gases and oxide particles is much higher in temperature than the blast-furnace metal to which it is added. The superheating action on the latter metal subjects the unstable carbon and silicon as carbide and silicide of iron to a secondary refining action. Some of the graphite is probably oxidized, and iron oxide from the Bessemer metal becomes reduced within the mass. The result is a lower-carbon iron with smaller nuclei of graphite than is found in hot-blast pig irons.

SLOW VS. RAPID REFINING

The relative action of slow and rapid refining as typified in the production of practically carbonless iron in the puddling and open-hearth furnaces is well illustrated in the two micro-photographs, Figures 5 and 6 (100 diameters). Here the same raw materials were used in the open-hearth and puddling operations, the resulting refined irons being of similar analysis. The two irons were similarly reheated, piled and rolled. The difference in the size of the ferrite crystals is very pronounced, the puddled iron having much the coarser structure. The open-hearth iron, melted and refined

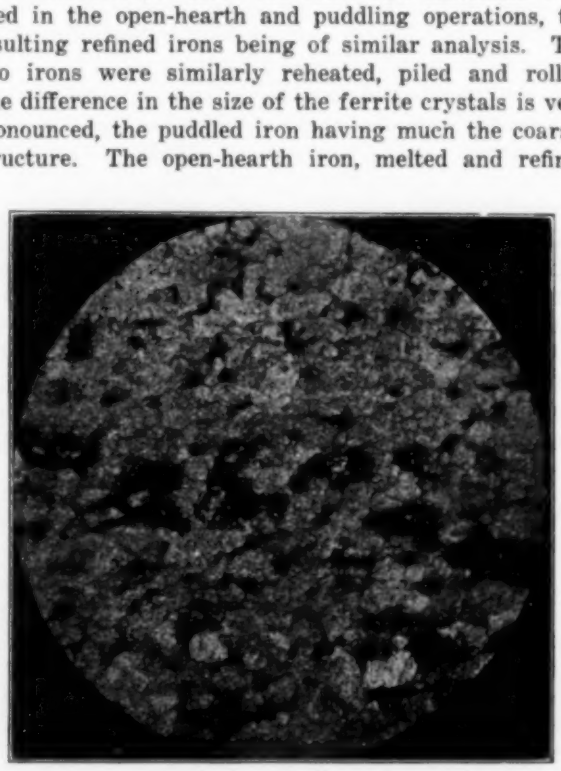


Fig. 5.
Open-hearth Iron.

Fig. 6.
Puddled iron.

under high superheat conditions, unassisted by artificial rabbling and agitation, has a finer crystallization than the puddled iron, which is refined at lower temperatures. This latter action, carried out in a hearth which is itself composed of active reducing oxides, must obviously tend to a coalescence and welding of adjacent iron grains or crystals which is impossible in a bath where the refining action proceeds by way of contact only with a superincumbent slag of low specific gravity and high visocity. It goes without saying that the question of crystalline metallic structure is inseparably connected with the slag functions. Micrographic analysis cannot reveal the true character of the boundary films, the process of polishing the slag inclusions being altogether unsatisfactory when it is desired to reveal the characteristic structures at high powers of magnification. It would appear, therefore, to be of increasing importance to study the crystalline boundary problem in the light of the foregoing conclusions, bearing in mind the facts that the crystals or crystallites begin to grow in a liquid carrying oxides, slaggy, gaseous or metallic.

These oxides, during their own decomposition, may form secondary crystals, or, in their passage to the slag covering, become entrapped as films within the contracting crystal boundaries.

New Bureau of Mines Stations

Secretary of the Interior Lane, in a recent departmental order, authorized the establishment of a mining experiment station at Columbus, Ohio, under the jurisdiction of the Bureau of Mines, the station to represent the ceramic industry of the United States. Columbus was selected as the site for the station because it is the capital of the state recognized as the center of the clay working and allied industries and also because the Bureau can work in cooperation with the School of Ceramics at Ohio State University. A station has also been authorized at Minneapolis, Minn., to represent the iron mining districts and to work in co-operation with the School of Mines of the University of Minnesota.

Refractory Magnesia

By R. C. Gosrow

The Eighteenth Ordinary meeting of the Faraday Society held in London, England, on Nov. 8, 1916, when a general discussion was held on refractory materials, brings to the attention of the metallurgical world, once more the need of more work and reliable data on refractories for high temperatures.

Having been directly interested in and working with magnesia as a refractory for several years past, my attention was drawn to the abstracts of the papers presented at the above meeting as given in METALLURGICAL AND CHEMICAL ENGINEERING of Dec. 15, 1916.

In the articles cited, Dr. R. S. Hutton of Sheffield made the plea for more work on the refractories that are used at the temperature of the electric furnace. He also mentioned the properties of completely shrunk magnesia as being quite different from ordinary calcined magnesia, and also that the shrinking could be economically effected electrically. It might be of value here to give an account and some data from my own experiences in the calcining of magnesite and the electrical dead burning and shrinking of the magnesia so formed.

The magnesite which was used was from a deposit in lower California, from which considerable quantities of magnesite had been mined and shipped in previous years.

The raw magnesite analyzed:

Insoluble	0.50 per cent
Al_2O_3, Fe_2O_3	0.90
$CaCO_3$	Traces
$MgCO_3$	98.10 per cent

This was a massive magnesite, white in color, and having a hard conchoidal fracture.

The raw calcining was carried on in a vertical kiln 30 in. inside diameter and 5 ft. deep. This was so arranged that a door on one quadrant near the bottom allowed the calcined material to be drawn out, and at 90 deg. with the draw hole was an opening 10 in. by 12 in. for a pressure air-oil burner. The burner was 15 in. from the bottom of the shaft. Lumps of magnesite 1½ in. to 3 in. were charged in such a way that the interstitial spaces between the lumps were not filled up, but allowed the gases to escape at the top of the kiln. The kiln was two-thirds filled, and firing started. As the top of this became hot, the kiln was slowly filled to its full holding capacity, the top always reaching a dull yellow heat before more magnesite was added. The kiln held bout 1200 lb. of raw rock. This was fired for 10 to 12 hours, when the whole mass was a bright yellow. The oil burner was shut off and this opening plugged tight. The top was covered and the kiln allowed to cool slowly overnight. The walls of the kiln were thin, to allow the mass to radiate its heat sufficiently fast to handle the material in the morning. The kiln content was drawn out on a flat sheet-steel plate and sampled. The analysis was:

Ignition loss	2.20 per cent
Fe_2O_3 and Al_2O_3	1.90
MgO	94.70
CaO	0.10
Insoluble	.85
	99.75

The magnesite lumps which occupied about three-fourths of the kiln's height, were burned to buff-colored clinkers, and showed no core in the 3-in. lumps, but fell apart easily with handling during the drawing and sampling. That portion which occupied the upper one-quarter of the kiln was not clinkered well and was powdery and white. But owing to the subsequent treatment of this calcined material, it was immaterial, regarding this fine soft material on top. The kiln was run on the described schedule until about 3600 lb. of magnesia was obtained. This magnesia was crushed to about ¼-in. size, and some unavoidably went to powder, and the whole then was divided up in 600-lb. lots.

These batches were then charged—600 lb. at a time—into the crucible of a 1-ton Stassano, 3-phase, arc-radiated steel furnace. The material was levelled up, and a current of 600-800 amperes carried at 150 volts for thirty minutes. During this time the magnesia was turned and rabbled to give it exposure to the flaming arc. Directly under the arc some magnesia fused to a hard slab, about 8 in. to 10 in. in rough diameter and about 1 in. thick. This was broken up and added along with the balance of the calcined material. Before charging each batch the furnace crucible was brought up to a bright yellow so that the furnace was hot when the material was charged into it.

The total amount of material charged in weighed 3600 lb. and the power consumption was 520 kw.-hr., metered on the secondary of the transformers. At 1c. per kw.-hr. the cost was $5.20, or a cost per 100 pounds of 14.4c.

The sampling was made on the cold material and showed 0.7 per cent loss on ignition by heating in an electric combustion tube furnace. The magnesia grains were hard and flinty, and scratched glass. They showed a specific gravity of 3.65.

A sample of ¼-in. lumps from this electrically burned lot showed no change in weight in moist air for ten days. Another sample, from the oil-fired kiln, previous to electrical burning, showed the following per cent increase in weight:

30 hours	2.5 per cent
44 hours	3.25 per cent
76 hours	3.70 per cent
100 hours	4.60 per cent
125 hours	5.25 per cent
150 hours	5.60 per cent
172 hours	6.00 per cent

The purpose of carrying on the work on magnesite and magnesia was to prepare a satisfactory dead burned and shrunk magnesia that would be suitable for lining the hearth and walls of an electric steel furnace.

The result desired was a monolithic lining, including side walls and hearth. In order to provide against any subsequent cracking or shrinkage it was considered essential to first take out all the shrink from the raw material, before setting in the furnace.

It may be of interest and value to give here the results of the first monolithic lining which was put in. The work was partially a success, and partially a failure. Both results may interest someone. The electrically burned magnesia was ground to about 6 mesh and thoroughly mixed with 10 per cent of powdered ferric oxide (80 mesh) and 5 per cent of a basic steel furnace slag. This mixture, approximating 4200 lbs. in weight, was heated in 1000 lb. batches, on a steel-plate frame, and well-boiled tar, to about 12 per cent, thoroughly mixed and heated with the basic materials. The mixture was rabbled well to insure coating of the grains with the hot tar.

The hot mix was then rammed in the side walls of the furnace, and around a steel-plate form, for the crucible. The side walls were 10 in. thick at the bottom and 7 in. thick at the top and 42 in. high. Steel hand rammers were used, and only small layers put in at a time, but constantly, and rammed hard. When the lining was completed the inner steel form was removed, and the inner surface smoothed up. The hearth in the furnace was put in on the old bottom. The roof was then replaced.

Before firing, the material was given 3 hours to air-set, and then an oil burner was set in the tapping-spout opening. The charging doors were opened and the oil burner lighted. A very small smoky flame was used, and eventually, as the walls became heated, distillation of the tar in the binder took place. Eventually the volatile gases burned and the excess tar was burned out, leaving principally a carbon residue between the grains of the material. It was given about 4 hours for the "smoking" and burning of the tar to take place. Gradually the heat from the burner was increased, until in about 8 hours the furnace was a bright yellow. The lining showed one small crack directly opposite the oil-burner flame, in a vertical position. The lining was extremely hard, and gave a metallic ring when hit with a steel bar.

At the end of 8 hours on oil firing, the electrodes were put in and the arc formed. (The furnace was a one-ton Stassano, radiated arc.) The heating took place evenly and without any further cracking developing in the lining. The walls and hearth were a bright yellow, and cold scrap was charged for a wash heat. About 1200 lb. was charged, and melting proceeded rapidly.

During melting, it was observed that directly over the electrode ports the magnesia mixture was falling down and accumulating on the electrodes. Eventually enough material fell onto the electrodes to cause a bridging across from one side of the port to the other, a distance of 5 inches. This material was white hot. When the last of the 1200-lb. charge was poured from the furnace, the furnace interior was a dazzling white. The lining was apparently in good shape so far as cracking or shrinking was concerned. But a considerable "sluffing-off" effect was noticed by an accumulation of material at the base of the walls, on the hearth. The lining was a dazzling white, and the arc was almost "out." The electrodes were brought nearer together, and a short arc could only be maintained. When the furnace-charging doors were opened large quantities of small floating particles of white substance floated through the air, coming from the furnace openings. These small particles in the air gradually spread out into feathery particles. This material was analyzed and showed magnesia to be the main ingredient, with some silica.

The "sluffing-off" effect became so great, that the hearth was covered with the material of the lining and the lining was now only about 4½ in. thick on the walls above where the slag line would be. Considering the uncertainty of this lining it was decided to repair the furnace with bricks and get back to producing steel castings and not holding up business with experiments.

The experiment showed several things, which have since then been useful in putting in monolithic linings of magnesia for ferro alloy furnaces:

1—After cleaning out some of the highly heated material, it showed considerable ferrous oxide, and a honeycombed structure which resembled incipient fusion and decrease in volume.

2—It was considered the mix was too high in iron oxide.

3—Hand ramming is difficult to give uniform density on so great a volume of material. Air rammers would be more desirable.

4—The lining walls were too thick, not allowing the effect of the heat to penetrate rapidly enough to burn and frit the whole wall. The inner wall was burned hard, but halfway through the material had no bond, and was very destructible and friable, which was evidenced by the "sluffing" effect.

5—Precautions are necessary to make hard and dense the material over openings, so this material doesn't sluff and fall down on the electrodes, short circuiting the current through the lining.

6—Rapid heating after burning out the tar and rapid heating to a maximum temperature appeared essential.

7—The desirability of using other binders than tar.

8—Futility of carrying on an experiment in apparatus for plant operations and interfering with plant output.

These results are given to show some causes of failure in monolithic linings.

In the past two years the writer has had considerable success in the application of monolithic basic linings, for ferro alloy furnaces, and other basic smelting processes, on tungsten, molybdenum and manganese.

Milwaukee, Wisc.

Concrete Ships.—The following extract taken from a letter from the Construcciones y Pavimentos, Barcelona, Spain, should prove very interesting:

"You know that is actually a very interesting question, as much in Europe as in America, the construction of reinforced concrete ships, being as they are more economical and of easier and more rapid construction than those of iron or timber.

"The only fault we can appoint about the reinforced concrete ship hulls, is their fragility at a clash. But we have the honor of informing you that Mr. J. Capmany, engineer chief of our reinforced concrete section has presented a letter of mark about a disposition by which this fault is, in a very simple manner, put aside, avoiding, in what the practice limits do permit it, the production of slits, making by this reason the reinforced concrete ships as sure for the navigation, at least, as those of iron.

"As we believe this notice will surely be interesting for the readers of your review, we have the greatest pleasure in putting it on your knowledge."

Nitrogen Fixation in Germany.—The production of ammonia in Germany by the Haber synthetic process, according to the *Frankfurter Zeitung*, rose from 30,000 tons in 1913 to 60,000 tons in 1914, 150,000 tons in 1915, and 300,000 tons (estimated) in 1916. An output of 500,000 tons of ammonia is anticipated in 1917, containing 100,000 tons of nitrogen; at the same time 700,000 tons of sulphate of ammonia (140,000 tons of nitrogen), and 400,000 tons of calcium nitrate (80,000 tons of nitrogen) are expected to be produced, the total including 320,000 tons of nitrogen, which exceeds by 100,000 tons the entire consumption of nitrogen in Germany in 1913.

A Scientist Officers' Reserve Corps

By Guy Y. Williams

Professor of Physical Chemistry, University of Oklahoma

President Stieglitz's proffer of the services of the members of the American Chemical Society to our Government in case of war and its grateful acknowledgment by President Wilson indicates that the services of our chemists will be used in helping our country win the present war.

European experience has shown that the war is largely a conflict between men of science. It is largely a war of chemistry and engineering. The various governments are employing their men of science in devising means of offense and defense. Problems of such unusual character arise that the most highly trained scientists and technicians are required for their immediate solution. Not only are chemists and other scientists acting as advisers to their governments but they are in the factories and upon the battle-field. University laboratories have been turned into small factories for the production of medicines, and analytical work on munitions and other supplies is now being done in a great many college laboratories. Students physically unfit for field service are usefully employed, under the direction of their professors, for the production of supplies.

The Germans used the poisonous gases produced by their chemists. The English and the French sent their chemists upon the battle-fields and into the trenches to combat chemistry with chemistry. The Universities, technical schools, and the chemical societies furnished this new army unit.

English experience[1] has shown that any government in time of war should have such an organization of professional chemists, so that the many requirements of the navy, the army and the aviation forces can be promptly and efficiently met. In addition to the great men of science acting for the most part in advisory capacities, it is necessary that chemists should control the manufacture of munitions, explosives, foods, drugs, metals, paper, rubber, oils, gases, etc. Chemists are required for analytical work and research. Chemists are used at the front to handle water supplies, to detect poisons in streams, to inspect, analyze and pass upon the soldiers' rations, to dispose of sewage and to assist generally in camp hygiene and sanitation.

That we are profiting by the experience of our French and English allies is shown by the following facts:

1. The Council of National Defense, through the Bureau of Mines in co-operation with the American Chemical Society, has prepared a roster of the chemists of the United States. Similar rosters of technically trained men are being prepared in all other scientific branches. Lists of seniors, majoring in scientific and technical subjects and in the foreign languages, have been requested of the universities by our government.

2. The recently organized Intercollegiate Intelligence Bureau has done a much needed work. Through state directors and their adjutants, it has collected data from the various universities and colleges with regard to the fitness of their students and alumnae for government service in the present war and possibly in subsequent wars. The collected data will enable the government to fill vacancies in offices, plants, factories, and the industries, and to put the trench chemist upon the battle-

[1] Chemistry in Wartime, Richard B. Pilcher. Proceedings of the Institute of Chemistry (1917).

field in a shorter time than it would otherwise be possible.

3. Advisory boards of the different branches of science have placed themselves at the command of the government to suggest lines of research and to aid in the conservation of our resources.

But will this give our government the kind of an organization that can be handled immediately and to the best advantage? From the point of view of a chemist and a former officer in the National Guard, I fear that it will not.

A scientist officers' reserve corps created upon about the same basis as the engineer officers' reserve corps would aid our government to as great an extent as any other officers' reserve corps. Let us have a group of scientific men who know something about military discipline, who realize the importance of time in military operations, and who are ready to report at once to any place designated by a war department order. Let us require of these officers certain educational qualifications, or their equivalent in practical work, in their particular fields. The English chemists who were in the teaching profession are now used as war chemists. Why not educate the American chemistry teacher, so that he can step out of the class room into the industries and immediately take up some line of work that would add to our country's munitions and food supplies?

A great many of our theoretical chemists and a greater number of our teachers of chemistry know very little about commercial chemical processes. Many of our chemists would grasp the opportunity to make a study of our commercial plants and processes, if they could be furnished with the means to do so. If a teacher of chemistry were an officer in the chemists' section of the scientist officers' reserve corps, and were required to spend 30 days each year studying commercial processes, on the same pay and allowances of regular army officers of equal rank, it would not be long until our government would have a large group of chemists well trained for public service, and our schools would profit from the contact of their instructors with actual plant and factory methods.

In Oklahoma, for example, a chemist reserve officer might spend one summer in the petroleum industries, another summer in the zinc smelters, and still a third summer in the glass factories. He might be ordered East for a summer's work in a munitions plant or required to work at nitrogen fixation processes until he is an expert in this one line only. Many chemists would be glad to give their services to the government in case of need, and those in the teaching profession could be made proficient in one industrial line if a plan as generally outlined above and as specifically outlined below were put into operation by our government.

I have carefully read that part of General Orders No. 32, War Department, July 28, 1916, that deals with the officers' reserve corps and have come to the conclusion that a scientist officers' reserve corps is not only possible, but that it is as necessary as any other branch of the officers' reserve corps. The following outline of the organization of the scientist officers' reserve corps conforms in general to that outlined for other corps. It is different only in that it establishes a new branch of the officers' reserve corps with duties specifically different from those of any present branch. There is a great deal of certain parts of G. O. 32 that fits the plan exactly, hence the wording is practically the same as that of this order and certain portions are quoted verbatim.

Section 37 of this order modified for our purposes should read:

The Scientist Officers' Reserve Corps.—For the purpose of securing a reserve of officers available for service as scientists temporarily in the service of the government, there shall be organized, under such rules as the President may prescribe, a scientist officers' reserve corps. Said corps shall consist of men selected from the various branches of science, and shall be divided into sections corresponding to the different branches of science. Except as otherwise herein provided, a member of the scientist officers' reserve corps shall not be subject to call for service in time of peace, and shall not without his consent, be called in a lower grade than that held by him in the said reserve corps.

The President, alone, shall be authorized to appoint and commission as reserve officers in the various sections of the scientist officers' reserve corps, in all grades up to and including the rank of major, such citizens as, upon examination prescribed by the President, shall be found to be physically, mentally, and morally qualified to hold such commissions. The proportion of officers in any section of the scientist officers' reserve corps and the total number in the corps shall be determined by the President.

Appointments for this corps shall not be dependent upon age, but shall be dependent upon educational qualifications, experience and special fitness for this service. When honorably discharged from the services of the United States, the scientist officer shall be entitled to retain his official title and, on occasion of ceremony, to wear the uniform of the highest grade he shall have held in the officers' reserve corps.

The Secretary of War, in times of peace, may order officers of the scientist officers' reserve corps, with their consent, to active duty in the services of the United States in such number as the public interests may require and the funds appropriated permit, and may relieve them from duty when their services are no longer necessary. While on such duty, they shall receive the pay and allowances, including pay for periods of sickness and leaves of absence, of officers of corresponding rank and length of active service in the regular army.

The commissions of all officers of the scientist officers' reserve corps shall be in force for a period of five years unless sooner terminated in the discretion of the President. Such officers may be recommissioned, either in the same or higher grades, for successive periods of five years, subject to such examinations or qualifications as the President may prescribe: Provided, that officers of the scientist officers' reserve corps shall have rank therein according to grades and length of service in the grades.

Section 38 of G. O. No. 32, W. D., 1916, somewhat modified, follows:

The Scientist Officers' Reserve Corps in War.—In times of actual or threatened hostilities the President may order officers of the scientist officers' reserve corps to temporary duty in any plant, factory, or industry that is producing supplies needed by the Government in prosecution of the threatened or actual war. While such reserve officers are in such service, they shall by virtue of their commissions exercise command appropriate to their rank, or in such a manner as the President may prescribe, and shall be entitled to the pay and allowances of the corresponding grades in the regular army with increase of pay for length of active service, as allowed by law for the officers of the regular army, from the date upon which they be required, by the terms of their orders to obey the same: Provided, that those so ordered to active service shall take temporary rank among themselves, and in their grades in the sections to which assigned, according to the dates of orders placing them in active service; and they may be promoted in accordance with such rank to fill vacancies that may occur in the section to which they are assigned: Provided further, that officers of the scientist officers' reserve corps shall not be entitled to retirement or to retired pay, and shall be entitled to pension only for disability incurred in the line of duty and while in active service.

Any officer who, while holding a commission in the

scientist officers' reserve corps, shall be ordered to active service by the Secretary of War, shall, from the time he shall be required by the terms of this order to obey the same, be subject to the laws and regulations for the government of the army of the United States, in so far as they are applicable to officers whose permament retention in the military service is not contemplated.

Section 39 of the above mentioned order has been changed to read as follows:

Instruction of Officers of Scientist Officers' Reserve Corps.—To the extent provided for, from time to time by appropriations for this specified purpose, the Secretary of War is authorized to order reserve officers in the scientist reserve corps to duty in plants, factories or industries, or for theoretical instruction for periods not to exceed 30 days in one calendar year, and while so serving such officers shall receive the pay and allowances of their respective grades in the regular army: Provided, that with the consent of the reserve officers concerned and within the limits of the funds available for the purpose, such periods of duty may be extended for reserve officers, as the Secretary of War may direct: Provided further, that in time of threatened or actual hostilities, after all available officers of any section of the scientist officers' reserve corps shall have been ordered into active service, volunteer officers may be appointed to fill such vacancies as may exist in any plant, factory or industry requiring the services of such officers.

Purification of Tannery Wastes

Experiments on the purification of tannery wastes by precipitation with copperas, primary filtration through cinders and secondary filtration through sand, conducted at Luray, Va., and Cincinnati, Ohio, by the U. S. Public Health Service, gave such good results and were so successful in arousing interest among tanneries that three Virginia tanneries combined to build and operate a working-scale plant at Luray with a daily capacity of 10,000 gal., according to the *Engineering News-Record*. The co-operating tanneries are the Deford Leather Co., Luray; the Leas & McVitty Co., Salem; and Cover & Sons, Elkton.

The original tests, which were made at the first-named plant and at the tannery of Haffner Brothers, Cincinnati, have been described by Harry B. Hommon, sanitary chemist, U. S. Public Health Service, Cincinnati, in a paper printed in the Journal of the American Leather Chemists' Society. They show the following results, starting with composite samples from the various elements of the tannery: Suspended solids, reduced from 1200 p.p.m. in the raw wastes to 450 in the settling-tank effluent, to 160 in the cinder, and to 30 in the sand-filter effluent; organic and free ammonia, 70, 55, 30 and 25 respectively; oxygen consumed (30 min. at 96 deg. C.), 900, 530, 205 and 55. The cinder filters were operated at a rate of 250,000 and the sand filters 300,000 gal. per acre. The cinder filter gave 0.29 p.p.m. of nitrites and 6.0 of nitrates; the sand filter 0.17 and 23.0 respectively.

Mr. Hommon expresses the conclusions drawn from the small-scale experiments and their practical application in the larger or 10,000-gal. unit at Luray, as follows:

1. "A storage tank for spent tan liquor is to be used, also for treatment of this liquor with lime sludge if it is strongly acid. As it is customary to discharge tan liquor intermittently or but once a day, this tank is required to distribute the flow throughout the day. For the 10,000-gal. plant at Luray, duplicate tanks, each 10 x 6 ft. in plan and 3½ ft. deep, with dosing appliances, are provided.

2. "A solution tank for the ferrous sulphate (copperas) solution. These tanks are in duplicate, each 1½ x 2½ ft. in plan and 2 ft. deep, and have the necessary regulating devices.

3. "A settling tank of sufficient capacity to allow a minimum detention period of two hours computed on the displacement basis. The tank for this purpose at Luray is 20 x 8 ft. by 11 ft. deep, and contains baffles and scum board.

4. "Cinder filters having a total depth of 5 ft. of cinders, or 4 ft. exclusive of the underdrains. At Luray this is 42 x 30 ft.

5. "Sand filters. Since as good results were obtained in the tests with a depth of sand of 2 ft. as with 5, the sand filter at Luray is divided into three sections having 2, 3 and 4 ft. of sand laid over underdrains which occupy a maximum of 1 ft., sloping to zero at the sides. Separate outlets are provided for each section for taking samples, and provisions were made to increase the depth of the shallow sections if it becomes necessary. These filters, as well as the cinder filters, will operate at a rate of 200,000 gal. per acre per day.

6. "Sludge beds, with sloping bottoms, containing 1 ft. of cinders overlaid with 4 in. of sand. For a 10,000-gal. unit treating the type of wastes produced at Luray, an area of about 600 sq. ft. is required.

"In the operation of the testing units," states Mr. Hommon, "it was found that better results were obtained by operating the filters at low rates throughout the 24 hours, rather than applying the entire dose for a given rate during the working day. In the permament unit the settling tank is designed to store enough wastes during the day to operate the filters during the 14 hours the tannery is not in operation. During the latter part of the tests, sand filters 2 ft. deep gave as satisfactory results as the deeper filters, but these filters were only 1 ft. in diameter and the results were not directly comparable. It seemed advisable, however, to construct the larger filter in the permament unit of three different depths to definitely decide this point.

"It is recognized that a testing station operated under the constant supervision of a technical man may produce better results than can be obtained from the operation of a large plant under the control of an unskilled operator. It is also appreciated that small units like those operated in the tests may be more readily adjusted to temperature changes and other unfavorable conditions affecting the results. It was to learn how far the results obtained from the operation of the testing units could be duplicated in a large plant that recommendations were made to the tanners interested that they build and operate a large unit.

"The plant now under construction at Luray is to be under the general supervision of the government, but this will extend only to making analyses of samples sent to the government laboratory, and to occasional visits for the purpose of suggesting changes in construction and operation."

The 10,000-gal. plant has been in operation since the latter part of June, 1917. Although without technical supervision it is giving results even more satisfactory than those obtained by the small-scale tests.

The Public Health Service will publish a detailed report in the near future containing complete descriptions of the plants and the results obtained. Progress reports will also be published giving the results from the operation of the permament unit. The general supervision of the work described was conducted by Prof. Earl B. Phelps, Washington, D. C., under the immediate charge at Cincinnati field headquarters of Mr. Hommon.

Government Control of Iron-Ore

The British Minister of Munitions has assumed control of the iron mines of Cumberland and the Furness district of Lancashire. The iron ore of these mines is hematite of the highest quality, occurring as a replacement in limestone, and it was the ore on which Bessemer developed his process. At many of the mines there are surface dumps of low-grade ore that will under present conditions repay concentration.

What the Exhibitors Showed at the Exposition

Descriptions of Exhibits and General Photos of the Exposition

PAUL O. ABBÉ, New York. Five different types of ball and pebble grinding mills. The improved rotary cutter. Combined sifting and mixing machine. In charge of exhibit, Paul O. Abbé. Victor H. Werner, sales engineer. Ralph Garlick, supt.

ABBÉ ENGINEERING CO., New York. Line of Abbé ball and pebble mills, small tube mills, pulverizing machinery, rotary cutter.

H. R. ACKERMAN CO., INC., New York. Samples of aniline and dry colors, acid silk black P. X., acid wool black 4BX.

ACME TANK CO., New York. Wood tanks, Redwood tanks, Redwood pipe. In charge of exhibit, Frank Wenneis.

WM. AINSWORTH & SONS, Denver, Colo. Chemical balances with improved rider carrier and multiple rider attachments. In charge of exhibit, Robt. G. Ainsworth.

ALBERENE STONE CO., New York. Stoneware for laboratory tables, sinks, hoods, etc.

AMERICAN ANILINE PRODUCTS, INC., New York. Samples of dyes and dyed materials.

AMERICAN BITUMASTIC ENAMELS CO., New York. Showed various applications of Hermastic coatings in construction and industrial work, for protection against corrosion and for waterproofing.

AMERICAN BLAUGAS CORPORATION, New York. Compressed gas for laboratory use, lighting, cooking, etc. By-products of gas manufacture. Low explosive range. Mr. Geo. E. Beves in charge.

AMERICAN CERAMIC SOCIETY. Reception booth.

AMERICAN CHEMICAL MFG. CO., INC., Norfolk, Va. Samples of their "Hippo" waterproofing products and acid proofing products.

AMERICAN CHEMICAL SOCIETY. Reception booth.

AMERICAN COAL AND BY-PRODUCTS COKE CO., Chicago, Ill. Diagrams of Roberts flueless coke ovens, and by-products made therefrom.

AMERICAN CYANAMID CO., New York. Evolution of Cyanamid display; 8 large samples, including limestone, burnt lime, coal, coke, carbide, air, crude Cyanamid, Cyanamid. Cyanamid Secondary Products Display—10 samples, including synthetic nitric acid, synthetic urea, aqua ammonia, cyanide, ammonium sulphate, ammonium nitrate, Ammo-Phos, soilime (lime residue), Dicyandiamid; also phosphate rock. Birdseye view of Cyanamid Works at Niagara Falls. List and description of cyanamid products. Four panels: Water Power and Food; A Billion a Year from the Air; To Reduce Fertilizer Costs; Cyanamid Works, Ammo-Phos Works, Phosphate Mines Data. In charge of exhibit, E. J. Pranke, A. E. Bonn, J. P. Hubbell, C. D. Cohen.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS. Reception booth.

AMERICAN INSTITUTE OF MINING ENGINEERS, New York. Reception booth. Exhibit of minerals.

AMERICAN LA FRANCE FIRE ENGINE CO., New York. Fire extinguishers, gas masks, smoke helmets, and other fire and safety devices, including the Haywood acid hood.

THE AMERICAN METAL CO., New York. Spelter, lead, copper, gold, silver, gallium, platinum, palladium, zinc sulphate, copper sulphate, zinc oxide, zinc dust, salt cake, niter cake, muriatic acid, sulphuric acid, 60°+66° Be. molybdenite concentrates, zinc and lead minerals and ores. In charge of exhibit, H. M. Burkey.

AMERICAN STEEL PACKAGE COMPANY, Defiance, Ohio. "Defiance" steel drums.

AMERICAN SYNTHETIC COLOR CO., Stamford, Conn. Organic chemicals and intermediates. Mr. Hazzard in charge.

AMERICAN TRANSFORMER CO., Newark, N. J. Transformers for electrochemical or electrometallurgical use. High voltage transformers for Cottrell precipitation system.

ANACONDA COPPER MINING COMPANY, Perth Amboy, N. J. Exhibiting products showing various steps in the reduction of copper, starting from the Butte ores, to the commercial refined copper shapes such as ingots, wire bars, slabs, cakes, etc. Also an extensive exhibit of the important byproducts obtained in the electrolytic refining of copper such as copper sulphate, nickel sul-

phate, white arsenic, selenium in all its allotropic modifications, tellurium, silver, gold, platinum, palladium. Also are showing an extensive exhibit of Anaconda Electric electrolytic zinc, and zinc dust and the products of the International Lead Refining Co. Corroding lead, antimonial lead and common lead. In charge of exhibit, S. Skowronski, E. Oksen, R. P. E. Hermsdorf.

H. REEVE ANGEL & CO., INC., New York. Filter paper, "Labruco" rubber tubing, industrial filter papers, fat free strips for milk analysis, Whatman drop reaction papers, extraction thimbles, glass wool. In charge of exhibit, B. S. Proper and G. H. Brother.

ANTI-HYDRO WATERPROOFING CO., Newark, N. J. Demonstration of anti-hydro waterproofing compound, for rendering concrete, etc., waterproof, acid and alkali proof, oilproof and dustless.

APEX CHEMICAL CO., Brooklyn, N. Y. Finishes for wool, cotton and silk. Dressings for leather, discharge agents. Fixing agents for colors, sulphonating oils. Dr. S. M. Herman, Hugo Helburn, Chas. B. Rasenberger, Nelson Craig.

ARKELL SAFETY BAG CO., New York and Chicago. Elastic paper linings for bowls, drums, boxes and bags. E. D. Greene and Pedro J. Morales in charge.

ARMSTRONG CORK & INSULATION CO., Pittsburgh, Pa. Nonpareil insulating brick, Nonpareil corkboard insulation, Nonpareil high pressure covering, Nonpareil cork machinery isolation, Circle A cork brick, Linotile. Herbert Paschke, N. Y. representative, in charge.

ARNOLD, HOFFMAN & CO., New York, sole agents for the Mathieson Alkali Works, Saltville, Va., and Niagara Falls, N. Y.; Nitrogen Products Co., Saltville, Va. Soda ash, caustic, bicarbonate, bleach, sodium ferrocyanide, sodium cyanide, starch, gums, and various other chemicals. Messrs. Hayes and Hall in charge.

J. T. BAKER CHEMICAL CO., Phillipsburg, N. J. Samples of "Bakers Analyzed" chemical reagents. In charge of exhibit, J. T. Baker.

BALTIMORE, MD., city exhibit, showing the industries of Baltimore, including chemicals, metallurgical industries and allied chemical industries. A model of the city was also on display.

BARBER ASPHALT PAVING CO., Philadelphia, Pa. They showed various chemical and industrial products into which Trinidad and Bermudez Natural Lake Asphalts and Gilsonite enter as a base material. They are featuring with a microscopic exhibit the collodial matter occurring in Trinidad asphalt, also a method for lining acid tanks with an asphalt mastic material. They are also showing their very complete line of roofings, shingles, paints, sealing compounds, marine enamels, etc. During the week a moving picture exhibit was given showing in detail the history of Trinidad Lake Asphalt and products produced therefrom. In charge of exhibit, H. C. Hottel, H. M. Menner, E. J. Carlin, Theo. Thomas, A. S. Lewis, J. S Miller, Jr.

BARRETT COMPANY, New York. A complete display of the products of coal distillation.

BAUSCH & LOMB OPTICAL CO., Rochester, N. Y. Metallurgical microscope, metallographic equipment, photomicrographic apparatus.

THE BAYONNE CASTINGS CO., Bayonne, N. J. Monel metal castings and rods and nickel castings. Had the largest nickel casting made in U. S. A., on exhibition at their booth No. 293. In charge of exhibit, H. F. Chase, sales manager, J. L. Fitzheury and F. N. Longyear

BEACH-RUSS CO., New York. Vacuum pumps, automatic oiling systems.

BECKLEY PERFORATING CO., Garwood, N. J. Miniature drying oven, high pressure ammonia tank, centrifugal tank, special tanks of all kinds. Perforated metals, brass, copper, steel, lead, aluminium, monel metal for sizing and straining purposes. Storage tanks of all sizes. Electrically welded steel any shape desired. In charge of exhibit, Allen L. Price, Theodore P. Carlson.

BETHLEHEM FOUNDRY & MACHINE CO., New York. Chemical apparatus of tantiron, acid eggs, caustic pots, nitrators, autoclaves, comparative test showing corrosive action of a 2 to 15-lb. solution of nitric acid on tantiron and cast iron, with resistance of the former.

P. BLAKISTON'S SON & CO., Philadelphia, Pa. Scientific books.

VICTOR G. BLOEDE CO., Baltimore Finishing Co., Viscamite Co., Baltimore, Md. Gums, dextrines, dyes, chemicals and colors. Exclusive contract with Government for gum on postage stamps. Dyers and finishers of cotton fabrics. Specializing in khaki, clothing, wigans starch finishes and general finishes for cotton clothing cloth. Viscamite, patented vegetable glue to replace animal glue. In charge of exhibit, V. Bloede, E. L. Greensfelder, L. B. Kilmer.

BOOTH FELT CO., INC., Brooklyn and Chicago. Samples of mechanical felt goods and felt specialties of all kinds. Mr. Booth and Mr. Gaizer in charge.

BOYER OIL CO., New York. Vegetable seed and nut oils.

THE BRASSARD CHEMICAL CO., New York. The main feature of The Brassard Company Incorporated's attractive exhibit this year was a map of the Atlantic Ocean showing the United States and the Western European countries connected by steamship lanes to various ports, illustrating the export connections of the company. They have specialized in the exportation of drugs, industrial chemicals, paint makers', varnish makers' and leather manufacturers' supplies. Another interesting exhibit is that of "British-made" Sulphur dyes (Hydrosulphon colors), manufactured by F. à Brassard & Crawford of Wakefield, England, one of the products particularly commented on being Hydrosulphon Indigo, with which a very fine indigo shade is obtained. Mr. W. A. à Brassard, president of the company, and Mr. Henry C. Elfast, were in attendance at the booth.

BRISTOL COMPANY, Bristol, Conn. Line of Bristol temperature indicators and controllers. Manufacturers recording instruments.

BROWN INSTRUMENT CO., Philadelphia, Pa. Demonstration of Brown pyrometers, Brown recorder for determining critical points of steel, Brown 8-record recording pyrometer and remote signaling pyrometer.

BUFFALO FOUNDRY & MACHINE CO., Buffalo, N. Y. The principal feature of this exhibit was a large vacuum drum drier for acids, chemicals, paints, glues, milk, food products and extracts. The main casing of this apparatus cast in one piece weighing 50,000 lb. When completely assembled the machine weighs 100.000 lb. The inner drying drum is 5 ft. diameter and 12 ft. long. A smaller size of this apparatus was in operation. Other exhibits comprised a Buflokast nitrator, fusion kettle, autoclave and apparatus used in producing heavy chemicals, acid, alkalis, explosives, intermediate products for dyes, etc. A piece of special interest was a new vacuum crystallizer for evaporating and crystallizing various materials. There was also a Buflokast denitrator for recovery of waste acids, capable of recovering nitric acid from waste containing as low as 2 per cent nitric acid and up to 30 per cent water, particularly from waste acids obtained in making gun cotton, TNT, dinitrobenzol, etc. The balance of the exhibit comprised Buflovak vacuum shelf driers and the new rapid circulation type evaporator. In charge of exhibit, E. G. Ripple, sales manager; H. D. Miles, president; O. S. Sleeper, P. J. Krentz, D. J. Van Marle, Otto Mantius, J. E. Doughton, Chas. Lavett, E. G. Sleeper, Homer Case, Geo. Pezold, H. Underwood, D. Bell, W. Dougan, Albert Feltz.

BUTTERWORTH-JUDSON CORPORATION, New York. Acids, chemicals, intermediates, dyestuffs. In charge of exhibit, E. E. Dougherty, G. T. Quinn, Dr. G. Drobegg, Dr. M. L. Hamlin, W. A. Lucas, W. H. Clark.

CALCO CHEMICAL CO., Bound Brook, N. J. Samples of the various dyestuff intermediates and finished dyes made by this company.

JOHN CAMPBELL & CO., New York. Aniline colors. In charge of exhibit, E. O. Attwater.

CANADIAN CHEMICAL JOURNAL, Toronto. Reception booth.

CANADIAN COLOR & OIL DAILY. Reception booth.

CARBORUNDUM COMPANY, Niagara Falls, N. Y. Carborundum products, pyrometer protection tubes, refractories, furnace linings, firebrick, firesand.

CAROLINA, CLINCHFIELD & OHIO R. R., Johnson City, Tennessee. Pottery products, wood products, nonmetallic minerals, metallic minerals, building materials. In charge of exhibit, V. V. Kelsey, Stuart Johnson, J. A. Bates.

CARRIER ENGINEERING CORPORATION, New York. Apparatus for conditioning and drying air. Automatic humidity regulation.

CELITE PRODUCTS CO., New York. Exhibit of sil-o-cel products for high insulating purposes. Brick, powder and various other products. P. A. Boeck, in charge.

CELLULOID-ZAPON CO., New York. Lacquers and leather cloth.

CENTRAL DYESTUFF & CHEMICAL CO., Newark, N. J. Dyestuffs and intermediates.

CENTRAL SCIENTIFIC CO., Chicago, Ill. Exhibit of De Khotinsky, constant temperature drying ovens, water baths, incubators, etc., laboratory rheostats, analytical balances, Pyrex glassware, organic and industrial chemicals, etc.

TAKE ELEVATORS
EXHIBITS
ON THIRD FLOOR
NEWPORT CHEMICAL WORKS INC.

TAKE ELEVATORS
FOR EXHIBITS
ON THIRD FLOOR
DUPLOKAST
CHEMICAL
APPARATUS
TAKE ELEVATORS
EXHIBITS

CHEMICAL CATALOG CO., New York. Reception booth.

CHEMICAL COMPANY OF AMERICA, INC., New York. Samples of dyestuff intermediates and finished dyes.

CHEMICAL CONSTRUCTION CO., Charlotte, N. C. Reception booth.

CHEMICAL ENGINEER, New York. Reception booth.

CHEMICAL PUMP AND VALVE CO., Perth Amboy, N. J. Valves, check valves, packingless centrifugal pumps, etc. Mr. Antisell in charge.

CHEMISTS' CLUB, New York. Reception booth, photos of famous chemists.

CHILE EXPLORATION CO., Chile Copper Co., Chuquicamata, Chile. Copper ingots, the ore used, samples of electrolytic solutions, acid proof mastic tank linings and acid proof pipe.

CHROMOS CHEMICAL CO., INC., New York City. Benzoic acid, benzoate of soda, tannigen, ferro benzoate.

CLARK'S IRON FOUNDRY, Philadelphia, Pa. Clarkiron chemical castings. Large size acid blow case and sulphuric acid concentrating pan and cover.

CLENZALL MACHINES CO. OF AMERICA, St. Louis, Mo. Working model of Clenzall filter cloth washing machine. Mr. F. H. Ehnts in charge.

CLINCHFIELD PRODUCTS CO., New York. Barium products, sodium sulphide, feldspar.

CONDENSITE CO. OF AMERICA, Bloomfield, N. J. Phenolic condensation products, chlorinated naphthaline products, condensite and halowax. Molded electrical insulation as applied to automobile starting, lighting and ignition apparatus, molded commutators, high tension insulators, U. S. Navy wireless insulators and lamp sockets, electrical condensers and miscellaneous insulation, condensite molding preparations, impregnating enamels and cements. Halowax oils and synthetic waxes. Molded condensite as used in Edison disc phonographic records, moving picture machines, vending machines, fire extinguishers, welding goggles, surgical, dental and chemical apparatus, etc. In charge of exhibit, Sandford Brown, chief engineer.

CONSOLIDATED COLOR & CHEMICAL CO., New York. Colors, sizing and finishing materials, soluble oils.

CONTACT PROCESS CO., Buffalo, N. Y. Samples of sulphuric, nitric and hydrochloric acids, sulphide of soda, mixed acid, oleum, salt cake, nitre cake.

CORN PRODUCTS REFINING CO., New York. Corn products for technical purposes. Dextrines, starches, gums, oils, cellulose.

CORNING GLASS WORKS, Corning, N. Y. Chemical glassware, beaker's flasks, etc., made of Pyrex glass. Bakingware, Pyrex; railroad glassware, colored glass, instrument tubings, bulbs. Also showing Macbeth color Indication Unit, which is equipped with Corning glass. In charge of exhibit, J. F. Shaw, advertising manager.

THE CRANDALL PETTEE CO., New York. Revolving gas oven for all kinds of baking and drying purposes. This appliance is equipped with a heat regulator by which any desired degree of heat can be obtained and maintained constantly for any length of time without the attention of an attendant. Oven weighs two and a half tons and is suitable for all kinds of manufacturing purposes. In charge of exhibit, Paul Delaney.

CRANE CO., Chicago. Show a large line of valves and fittings for steam water, air, etc., in cast and malleable iron, ferro steel and cast steel. Among the specialties are an automatic stop check valve for boilers, a blow-off valve and the "Cranelap" Pipe Joint. Of particular interest is a complete 5-horse power industrial steam plant in actual operation. This miniature plant embodies the "Crane-auto" boiler-feeding system; the Crane Pressure Regulator and Temperature Regulator and the Cranetilt Lifting and Non-return Steam Traps. A coil kettle is heated to a definite temperature by the boiler, and the condensation is returned to the boiler —100 per cent efficiency is claimed. In charge of exhibit, W. L. Oswald, William Sink.

CRESCENT COLOR & CHEMICAL WORKS, New York. Colors and lakes.

THE J. H. DAY CO., Cincinnati, O. Demonstrating all kinds of mixing machinery. For heavy and light pastes, liquids and dry materials. R. W. Wallace, New York manager, in charge.

DE LAVAL SEPARATOR CO., New York. Centrifugal separators.

DENVER FIRE CLAY CO., Denver, Col. Metallurgical clay goods, crucibles, scorifiers, muffles. Clay tile, etc. Melting, assaying and enameling furnaces. Crushing and grinding machinery. In charge of exhibit, Messrs. Case and King.

DETROIT CHEMICAL WORKS, Detroit, Mich. Manufacturers of sulphuric acid, nitric acid, sulphate alumina. (Display samples lost en route.) In charge of exhibit, Edward S. Davis, secretary; Emerson Davis, treasurer.

DETROIT RANGE BOILER CO., Detroit, Mich. Exhibit a line of Perfect Metal Bilge-Barrels and Shop Barrels. Of peculiar interest is their Full Removable Head Barrel. In charge of exhibit, W. B. Goddard.

J. P. DEVINE CO., Buffalo, N. Y. A large Vacuum Drying Chamber that is a unit adapted to the handling of all materials that can be handled on trays or pans. There was installed in the J. P. Devine Co.'s booth a laboratory Vacuum Chamber Dryer Outfit complete with its condenser and dry vacuum pump. Also installed a Devine High Efficiency Vacuum Rotary Dryer that is a unit adapted to drying all materials that can be mixed or tossed in the drying. A 100 Gallon High Pressure Cast Steel Autoclave also on exhibition. Mr. Nathan Owitz, sales manager of the company, was in charge of the exhibit, and was assisted by Mr. L. W. Treichler, manager of the New York office, and Mr. A. D. Renner. Mr. F. F. Frantz, from the Buffalo office, is in charge of the moving apparatus.

DIAMOND STATE FIBRE CO., Bridgeport, Pa. Various samples of vulcanized fibre waterproof insulators. In charge of exhibit, R. F. Hunt, C. M. Bogert and Jas. McIntosh.

DOMINION OF CANADA, Department of Mines. Reception booth and maps showing mineral resources and water powers of Canada. J. T. Johnston, chief hydraulic engineer of the Government, in charge.

DORR COMPANY, New York. Operation of Dorr tray thickener and Dorrco diaphragm pump. Dorr agitator and classifier. In charge of exhibit, Messrs. J. V. N. Dorr, Fox, Spicer and Schaefor.

DOW CHEMICAL CO., Midland, Mich. Indigo, dyestuff intermediates and other chemicals.

THE DRAEGER OXYGEN APPARATUS CO., Pittsburgh, Pa. The Pulmotor, a mechanical resuscitation device for use in resuscitating the apparently drowned or asphyxiated from any cause. The Draeger Breathing Apparatus for breathing in any noxious fumes or smoke. In charge of exhibit, S. N. Fowler, O. L. Goudey, C. C. McDaniel.

DRAPER MFG. CO., Cleveland, Ohio. Drums for all purposes.

DURIRON CASTINGS COMPANY, New York. Duriron Acid Alkali Rust Proof Apparatus, including 2 x 1½ in. centrifugal pumps, 4 x 8 in. gear pump and reciprocating pump, newly designed triplex pump, capable of pumping against 300 lbs. pressure. Hough nitric acid condenser, plug cocks and valves, pipe and fittings, mixing kettle in operation, spray nozzles, laboratory apparatus, sulphuric acid cascade basins, absorption tower and plate-pipe showing special threaded connection to eliminate bolts for joints under surface of corrosive liquids, acid carboy lift, sundry special castings. In charge of exhibit, J. R. Pitman, Peirce D. Schenck, J. S. Miller, Jr., Fred W. Kolb, P. C. Schatzabel.

DYE PRODUCTS & CHEMICAL CO., INC., New York. Samples of aniline dyes for wool, silk, leather, paper and furs. Dyestuff intermediates.

EIMER & AMEND, New York City. Laboratory apparatus of all kinds, multiple replaceable unit, electric furnaces, Barnstead automatic water still, Erichsen metal sheet tester, Brinell hardness tester, etc.

ELECTRO BLEACHING GAS CO., New York. Liquid chlorine and products bleached with it.

ELECTROLYTIC ENGINEERING CORPORATION, New York. Photos showing actual installations of the Wheeler cell for making chlorine and caustic soda. Mr. Wheeler in charge.

ELECTROLYTIC ZINC CO., New York. Slab zinc 99.92 per cent pure, zinc wire, 99.92 per cent zinc shot, granulated zinc, zinc carbonate sulphate, oxide and chloride. W. H. Nagle in charge.

ELECTRON CHEMICAL CO., Portland, Maine. Photos of installations of the Allen-Moore chlorine and caustic soda, cell.

G. H. ELMORE, BLAIR, CAMPBELL & McLEAN, LTD., Scotland and New York. Designing and construction of chemical plants.

THE ELYRIA ENAMELED PRODUCTS CO., Elyria, Ohio. One seamless one-piece closed jacketed tank, 300 gallons capacity, with agitator. This has patented stuffing box jacket which allows quick renewal of inside tank and replacement by a new piece if severe chemical action causes wear. Also a cast iron jacketed still with

CONDENSITE COMPANY OF AMERICA

EXHIBITS

agitator. Every part quickly interchangeable, all made to gage. Also small and large steam jacketed evaporating kettles or dishes. Also steam jacketed kettle, 25-gallon capacity. All are arranged so that any part is easily replaceable. The cast iron enamel is very highly acid resistant and can be used with mineral acids of all kinds. Other small dishes, etc., are also shown. In charge of exhibit, Wm. E. Gray, John O'K. White, E. P. Poste, R. F. Goecke, Wm. E. Gray, Jr.

EMPIRE CHEMICAL CO., New Brunswick, N. J. Para toluidine, Ortho toluidine, W. S. nigrosene, jet, W. S. nigrosene, blue, S. S. nigrosene, blue, Para nitro aniline, mixed toluidine, Para nitro Ortho toluidine, Meta nitro Para toluidine, Para Amido phenol, Para nitro chor benzol. H. R. Cook in charge.

EQUITHERM CONTROL CORPORATION, New York. Industrial temperature control and electrical appliances electrically operated thermostats for all purposes to 1650 deg. F. Valves for low pressure steam, 2 in. to 14 in. High pressure steam, ½ in. to 6 in. Oil and air, brine, gas, oil and steam, gas and air, water, electric heat, oil, ammonia control. In charge of exhibit, E. B. Lane, H. W. F. Threse.

W. & L. FLEISHER & CO., INC., New York. Drying and air conditioning laboratory, in which any condition of temperature and humidity desired can be obtained. Working model under automatic control. In charge of exhibit, Messrs. Lissauer, Peabody, Fleisher.

FOOTE MINERAL COMPANY, INC., Philadelphia. As specialists in rare and semi-rare ores and mineral products the Foote Mineral Company of Philadelphia featured many materials of growing commercial interest, notably the following: "Cooperite," a patented alloy of nickel and zirconium, intended mainly for use in cutting tools for lathes, planers, boring mills, etc., was shown in mill bars and finished tools. Possessing a melting point of only about 1150 deg. C, this alloy can readily be cast, requiring no heat treatment, and only a minor grinding operation to finish. In a recent series of comparative tests at one of the large Eastern steel companies in cutting steels of varying degrees of hardness, "Cooperite" tools averaged several times longer before regrinding than the best grades of high speed steels. Among the ferro-alloys of tungsten, vanadium, uranium and tantalum, ferro-molybdenum finds its most important application in high grade steels, being used for rifle linings, armor plate, armor piercing shells, permament magnets, bank vaults, self-hardening and high speed machine tools. Molybdenum steel compares very favorably with tungsten steel and does not require as high a temperature for hardening. Several grades of Crimson and Golden Antimony were shown, especially adapted for use in the rubber industry; also thorium ore (monazite sand), from which the nitrate is obtained for use in the gas mantle industry; crude strontium sulfate, first imported by this company for the manufacture of the nitrate; cerium mixed metal, intended especially for the manufacture of pyrophoric alloys; "Zirkite" (natural zirconium oxide), which is being more and more recognized as a high grade refractory; manganese ore suitable for use in the dry battery and chemical trades; and an unusual collection of "Thulia" brands of the rare elements. In charge of the exhibit, Warren M. Foote, H. Conrad Meyer and Charles F. Walton.

FOXBORO CO., Foxboro, Mass.—Pressure and temperature recording and indicating apparatus. High resisting pyrometers, temperature controllers, differential recording gage. In charge of exhibit, Willis C. Brown, M. B. Hall, D. Bogan, L. H. Du Paul, J. E. Esherick.

FOUNDATION COMPANY, New York. Engineers and contractors for chemical plants and factories.

FREEPORT SULPHUR CO., Parsons & Pettit, New York City, Selling Agents. Photos showing extraction of sulphur.

CHAS. F. GARRIGUES CO., New York, agents for Virginia Smelting Co., producers of liquid sulphur dioxide. Samples of various chemicals.

GEISENHEIMER & CO., Agents for Ault & Wiborg Co., Cincinnati, Ohio. Dyestuff intermediates, chemicals, aniline oil and salt. Finished dyes, American and Swiss. Alfred F. Lichtenstein.

GENERAL BAKELITE CO., New York. Bakelite products, molding mixtures, varnishes, lacquers, enamels, cement, transparent and colored in sheet, rod, tube and special forms.

GENERAL CERAMICS CO., INC., New York. Western Sales Office, 112 West Adams St., Chicago, Ill. High grade, acid proof chemical stoneware apparatus and machinery. Those in charge, Percy C. Kingsbury, Evan S. Cameron.

GENERAL CHEMICAL CO., New York. Heavy chemicals. In charge of exhibit, J. E. Wilson, Jas. A. Branegan, J. R. de la Torre Bueno, N. L. Blay.

GENERAL ELECTRIC CO., Schenectady, N. Y. Indicating, recording, integrating steam or water flow meter. Tungsten metal and products. Coolidge X-ray tube.

GENERAL FILTRATION CO., Rochester, N. Y. Filtros plates, shapes, filters, etc.

GLENS FALLS MACHINE WORKS, Glens Falls, N. Y. Rotary sulphur burner.

GORDON ENGINEERING CORPORATION, New York. Standard size, two-section, Gordon dryer. In charge of exhibit, D. S. Baker, L. B. Darling, Mr. Murray.

GOULDS MANUFACTURING COMPANY, Seneca Falls, N. Y. Single-stage and two-stage centrifugal pumps, also rotary and plunger pumps, general water supply and special service pumps. In charge of exhibit, Harry R. Gumbert, W. H. Hopper, Harry Angel.

EMIL GREINER & CO., New York. Laboratory glassware specialties, centrifuges, electrically heated ovens.

GROCH CENTRIFUGAL FLOTATION, LTD., Cobalt, Ont. Working model of a complete oil flotation plant including tube-mill for ore crushing and agitator for the recovery of valuable minerals by the oil process. The distinctive feature of the Groch system is that agitation of the crushed ore with the oil and air is affected centrifugally in the interior of specially designed impellors and that by using suitable oil mixtures in series, various minerals in a complete ore can be recovered individually in one continuous operation.

THE GUERNSEY EARTHENWARE CO., Cambridge Ohio. Line of chemical laboratory porcelain, such as evaporating dishes, crucibles, retorts, funnels, porous cells, desicator plates, casseroles, combustion boats, mortars and pestles, pyrometer tubes, melting cups, porcelain spoons and spatulas, dye pots, etc., etc. In charge of exhibit, Allan L. Goulding, Prof. Paul E. Teetor.

HANOVIA CHEMICAL & MANUFACTURING CO., Newark, N. J. Samples of quartz glass, Heraeus laboratory apparatus, pyrometers, etc.

HARDINGE CONICAL MILL CO., New York. Small size, working model, Hardinge conical mill. Photos of many installations.

HARRISON SAFETY BOILER WORKS, Philadelphia, Pa. Working model of "Cochrane" V-notch meter in actual operation. Demonstration of hot process water softening. Cochrane separators and multiport valves, also a Creasy ice breaker. J. D. Yoder and W. W. Montalvo in charge.

HELLENIC CHEMICAL & COLOR CO. Samples of lakes and dry colors, anilines, intermediates and other chemicals. L. O. Seawood in charge.

HOSKINS MFG. CO., Detroit. Electric laboratory furnaces, pyrometers, indicating and recording; chromel thermocouples, resistor wire. In charge, F. L. Zimmerman, New York representative; C. S. Kinneson, advertising manager.

IMPERIAL COLOR WORKS, INC., IMPERIAL DYEWOOD CO., INC., JOHN H. HEALD & CO., INC., New York. Arthur Linz, New York sales manager; Wm. E. Burdett, secretary; K. R. McBride, in charge.

INDEPENDENT CHEMICAL CO., Sterling Color Co. (branch). Heavy acids. O. Crispens in charge. Prinuline S. F., direct fast yellows, reds, pinks, violet shades, all of which are fast to acid. R. H. Ringen in charge.

FRANK HEMINGWAY, INC., New York. Agents for Butterworth-Judson Corp. Samples of intermediates, dyestuffs, pharmaceuticals, special oils and greases, lake colors.

S. S. HEPWORTH CO., New York. Small standard size Mackintosh ball bearing centrifugals. D. M. Gardner in charge.

B. MIFFLIN HOOD BRICK CO., Atlanta, Ga. Acid proof brick, various shapes, spiral rings, radial towers and packing for Gay-Lussac and Glover towers. The spiral rings were of special interest in view of the difficulty of obtaining a correct spiral in a clay product.

HERCULES ENGINEERING CORP., New York. New Reed bowl, three-speed mixer. Mr. F. Mason.

HEROLD CHINA & POTTERY CO., Golden, Col. Exhibit of Coors porcelain ware for laboratory and industrial use. Evaporating dishes, casseroles, crucibles, boats, etc. Chas. F. Quaintance in charge.

HOOKER ELECTROCHEMICAL CO., Niagara Falls, N. Y. Chlorine, caustic soda and chlorbenzol products.

HOUSTON (Texas) REAL ESTATE & LOAN CO. Samples of Texas raw materials and products.

HUFF ELECTROSTATIC SEPARATOR CO., Boston, Mass. Demonstration of concentrations and separations produced by static electricity. Demonstration of the Plumb Pneumatic Jig for dry concentration of ores, wide range of results on samples of concentrations and separation of ores, on display. In charge of exhibit, A. L. Sweetser, member A. I. M. E.

HUNTER DRY KILN CO., Indianapolis, Ind. Processing and drying of rubber and compounds, using moist-air kilns, drying "from the inside out." In charge of exhibit, Harry Hunter, O. M. Ragsdale.

F. C. HUYCK & SONS, Albany, N. Y. Photos of the manufacture of "Kenwood" woolen filter cloths for chemical and industrial filtering purposes. Messrs. Wallace and McGovern in charge.

INDUSTRIAL FILTRATION CORP., New York. All metal rotary filter, type B-1. All metal rotary hopper dewaterer, type C-1. Open tank filter, type D-1. All models of the above types exhibited are exact miniatures of the standard machines. In charge of exhibit, Wm. H. Harding, Jr.; Henry B. Faber, George D. Dickey, Wm. H. Laughery, J. Rayden Hess.

INTERNATIONAL EQUIPMENT CO., Boston, Mass. Showed commercial and laboratory centrifugals.

INTERNATIONAL GLASS CO., Millville, N. J. Chemical glassware and apparatus for laboratory use.

JACQUES WOLF & CO., Passaic, N. J. Monopole oil (U. S. patentees), sulphonated castor oils, sizing and finishing products of cotton, wool and silk, mordants, gums, chrome colors for fabric printing.

JANNEY STEINMETZ & CO., Philadelphia, Pa. Pots and pans, special shapes high pressure cylinders. E. K. Mason, N. W. Slater, Manager N. Y. office, in charge.

JEWELL-POLAR CO., Chicago, Ill. Various types of Jewell-Polar stills.

JOURNAL OF COMMERCE, New York. Reception booth.

JOURNAL OF INDUSTRIAL AND ENGINEERING CHEMISTRY, New York. Reception booth.

KALBFLEISCH CORPORATION, KALBPERRY CORPORATION, New York City. Kalbfleisch Corporation showed samples of acids and chemicals made by the company. Kalbperry Corporation, industrial engineers.

KEYSTONE FIBRE PRODUCTS, INC., New York. Solether Gasket-Sheeting, a fibrous product for use in chemical plants, factories, mills, power houses., etc. Exhibit showing variety of unusual chemical tests and comparisons with other high class gaskets or packings. Also showing rolls of material of different thicknesses and widths as offered to the trade. In charge of exhibit, General Manager George H. Bruce, N. L. Morton, Engineer, and A. J. Schweiger, assistant.

KEYSTONE MINERALS CO., New York. Samples of Rottenstone, velvet filler, Keystone filler, mineral black. In charge of exhibit, Daniel Wonders and F. J. O'Brien.

KLEET MFG. CO., INC., New York. "Percollodion" membranes for rapid evaporation and crystallizing in laboratory work. Kober colorimeter nephelometer for measuring color and turbidity. In charge of exhibit, Messrs. R. E. Kleet, F. A. Boersch and C. W. Eberlein.

A. KLIPSTEIN & CO., New York. Dyestuffs, chemicals and tanning materials.

KNOXVILLE BOARD OF COMMERCE, Knoxville, Tenn. The Knoxville exhibit at the Chemical Exposition is designed to show, in physical displays and by maps and charts, the various varieties of minerals in the territory of which it is the geographical center, and, by virtue of its unique central location, emphasize its importance as a manufacturing center for plants utilizing the mineral resources surrounding the city on every side, as well as for plants that use the finished products of plants already in operation in that section. Among the metallic minerals shown in the Knoxville exhibit are to be found copper ore, iron ore, zinc ore, lead ore, bauxite, manganese. The non-metallic minerals include clays, shales, mica, phosphate, limestone, pigments. Petroleum is also an important resource exhibited, as is coal. Knoxville is within thirty miles of the nearest coal field in the Tennessee-Kentucky district and six miles of the farthest. Knoxville marble is also featured and is being advocated as a substitute for any material used for its lime content, the Knoxville stone analyzing 98 per cent calcium carbonate. It is also urged as an element in the manufacture of Portland cement. Forestry products are also interestingly exhibited. In charge of exhibit, Hugh M. Tate, Dr. C. H. Gordon, Prof. J. A. Switzer, A. M. Blow, C. A. Benscoter and J. L. Bowles.

H. KOPPERS CO., Pittsburgh, Pa. Map showing coke and benzol products in United States. Samples of coke and by-products made by the Seaboard By-Product Coke Co., Jersey City, N. J., in Koppers coke ovens.

THE LABORATORY SUPPLY CO., Columbus, O. Show a complete line of the well known quality of "Ohio" tested porcelain and guaranteed glassware. In charge of exhibit, R. C. Schroth, Jr., C. D. Fraunfelter.

LEAD LINED IRON PIPE CO., Wakefield, Mass. Forms of lead-lined pipe, valves and stop-cocks.

LEEDS & NORTHRUP CO., Philadelphia, Pa. A complete line of pyrometers, including both recording and optical pyrometers. The optical pyrometer is of especial interest, possessing both accuracy and simplicity. In connection with the recording instruments a red, white and blue light system of indicating variation, high or low, of the furnace temperatures from a fixed valve was shown. Apparatus for determining the conductivity of electrolytes was shown including the Vreeland oscillator for delivering a high frequency E.M.F. of pure sine wave. The new design of the Burrows Permeameter for magnetic measurements. Electrometric titration apparatus for determining chromium and vanadium. A useful type of hydrogen electrode was also shown. In charge of exhibit, E. A. Keeler, E. B. Estabrook.

LEHIGH CAR WHEEL & AXLE WORKS, LEHIGH FOUNDRY CO., LEHIGH STOKER CO., Fullerton, Pa.; FULLER ENGINEERING CO., Allentown, Pa. Small model of Fuller-Lehigh pulverizer mill. Special chilled castings. Photos of large chemical castings, pulverized coal installations and stokers. In charge of exhibit, Messrs. Stauffer, Mease and Stubblebine.

ARTHUR D. LITTLE, INC., Boston, Mass. Industrial research and scientific control. View of Cambridge, Mass., along Charles River, showing buildings of Massachusetts Institute of Technology, new building of Arthur D. Little, Inc.

STATE OF LOUISIANA. Timber, salt, sulphur, farm products.

WALTER E. LUMMUS CO., INC., Boston, Mass. Continuous concentrating and rectifying still, Lummus metrolift for liquids.

EMIL E. LUNGWITZ, New York. One type 450 power operated Kelly Filter Press, one type 30 Kelly Filter Press, one type 3 Kelly Filter Press. The 450 type on exhibit is of the latest and most improved style of Kelly Filter Press. Automatic locking device, power-driven and operating by compressed air. In charge of exhibit, Emil E. Lungwitz, C. L. Bryden, H. L. Dick, Carl Teichman and Herbert E. Soarez.

LUZERNE RUBBER CO., Trenton, N. J. Hard rubber products for chemical and industrial use and general rubber goods.

LUNKENHEIMER CO., Cincinnati, Ohio. A complete line of stop valves, bronze, iron body bronze mounted, all iron, semi-steel, and cast steel; lubricating specialties, boiler mountings, etc. In charge of exhibit, Phil. Smith.

MACHINERY UTILITIES CO., New York. Idle and used apparatus for the chemical industries.

MADERO BROS., INC., New York. Large line of drugs and chemicals.

MANUFACTURERS' RECORD, Baltimore, Md. Reception booth.

MARDEN ORTH & HASTINGS CORP., New York. Dyes, chemicals and textile oils. Display of dyed skeins of cotton, wool worsted and silk. In charge of exhibit, H. Gardner McKerrow, manager; S. M. Crain, Jr., assistant manager.

MERCK & CO., New York. Blue label chemical reagents.

METALS DISINTEGRATING CO., New York. Metallic zinc, tin, lead, aluminium, copper and magnesium powders and zinc, tin, aluminium and copper flakes. In charge of exhibit, S. G. Schatzberg.

THE METH-O-LENE CO., INC. American-made dyes and colors. Exhibits of silks, cottons, straws, papers and crayons. In charge of exhibit, Harry F. Heckendorn.

H. A. METZ LABORATORIES, INC., New York. American-made synthetic local anaesthetics.

MINE & SMELTER SUPPLY CO., Denver, Col. Wilfley table, Marcy mill, Heusser balance with multiple weight attachment and mechanical pan extractor; Samson laboratory construction, McCord pulverizer, McCann sampler, Jones sampler, Mossco crucibles, scarifiers, mufflers, metallurgical clay tile, Lindsay oil furnace, laboratory gas furnace, Coors porcelain ware. In charge of exhibit, J. C. Evans, E. S. Tompkins, J. S. Shedden.

MOGUL CO., New York. Photos of various kinds of acid, alkali and waterproof insulation in actual use.

MONARCH MANUFACTURING WORKS, Philadelphia,

Pa. Chemical atomizing spray in actual demonstration.

MONSANTO CHEMICAL CO., St. Louis, Mo. Samples of acetanilid, aspirin and many other similar products.

MOORE & SIMONSON, New York. Lead burning. In charge of exhibit, W. H. Simonson.

J. L. MOTT IRON WORKS, New York. Enamelled iron kettles, evaporators, etc.

MOULTON ENGINEERING CORPORATION, New York. Photos of chemical and industrial plants, constructed or designed by the company.

MULTI METAL SEPARATING SCREEN CO., New York. Wire cloth, metallic filter cloth, testing sieves, Pulmosan face masks, chlorine helmets, etc.

NASH ENGINEERING CO., Norwalk, Conn. Nash hydroturbine air compressor and vacuum pumps, Jennings return line vacuum heating pumps and dryer exhaust units.

NASHVILLE, CHATTANOOGA & ST. LOUIS RY. A comprehensive exhibit showing not only the wide variety of raw materials available in the South, but the manufactured products made from these raw materials. Very large descriptive map showing the location of the various raw materials.

NATIONAL ANILINE & CHEMICAL CO., New York. Exhibit of the varied line of dyestuffs made by the company and a large number of different kinds of materials dyed with the company's dyes.

NATIONAL GUM & MICA CO., New York. Glues, gelatines and adhesives.

NEW JERSEY PRODUCTS, INC., New York. Coal products, organic chemicals, Edison Portland cement, Edison alkaline storage battery.

NEWPORT CHEMICAL WORKS, INC., New York. Products of coal tar distillation, also turpentine and pine oil from Northern woods.

NEW PROCESS CHEMICAL CO., New York. "Nupro" waterproof and acid-proof cements and paints for chemical and metallurgical purposes. In charge of exhibit, George T. Simonson, August Schlueter.

NEW YORK CITY HEALTH DEPARTMENT. Products of food dehydration.

NEW YORK COMMERCIAL. Reception booth.

NEW YORK REVOLVING PORTABLE ELEVATOR CO.,

Jersey City, N. J., Non-revolving and revolving base portable elevators for heavy lifting such as in piping barrels, cases, bales, rolls, etc., or in lifting heavy drums of chemicals to the height at which they may be either siphoned or the contents poured into a tank or other container. In charge of exhibit, F. J. McMahon and John Kurtz.

NIAGARA ALKALI CO., New York. Caustic soda, caustic potash, chlorine by-products.

NORFOLK & WESTERN RY. CO. Raw materials. Photos of some of the large industrial plants. Possibility for future development. Pyrrhotite (largest deposit in United States). In charge of exhibit, E. A. Schubert.

NORTON CO., Worcester, Mass., and 151 Chambers Street, New York. A practical working exhibit showing the application of alundum and crystolon in the manufacture of refractories and laboratory ware, such as alundum cores, muffles and tubes for small electric-furnace construction; extraction thimbles, filtering crucibles; ignition crucibles, pyrometer tubes, etc. The use of these two materials, alundum and crystolon, as abrasives for nearly all classes of work, from grinding of manganese steel to polishing microscopic specimens of all materials, was also shown. In charge of exhibit, M. A. Williamson, 151 Chambers Street, New York.

OBEX COMPANY, New York. Dye woods and dyestuffs, Logwood, Osage orange, Brazil wood, fustic. Dye extracts and dyed products.

OHIO POTTERY CO., Zanesville, Ohio. American-made chemical porcelain for laboratory use.

OLIVER CONTINUOUS FILTER CO., San Francisco. Two Oliver continuous filters shown in actual operation. R. G. Walker and L. D. Drake in charge.

PALO COMPANY, New York. Hess-Ives Tintphotometer, Dr. Waldo's Hardness Tester, Rhotanium, a substitute for platinum, Palo electric heaters, Palo analytical balances, Link's automatic waterstills, Palo chlorinator, Despatch electric ovens, C. L. & E. electric ovens, multiple unit furnace. In charge of exhibit, F. Rohde, C. E. Thies and M. J. Leavy.

PAPER, INC., New York. Reception booth.

PAPER MILL AND WOOD PULP NEWS, New York. Reception booth.

PENNSYLVANIA SALT MFG. CO., Philadelphia, Pa. American shield and attractive sign of salt crystal. Replica of Bunker Hill monument, cast of ammonium sulphate. Chlorine and alkali. Model of Wedge furnace.

PFAUDLER CO., Rochester, N. Y. Enameled, jacketed mixing tank with removable cover, also one-piece closed tank; kettle with new type of adjustable agitator; closed storage tank and pots in several shapes.

PHILADELPHIA QUARTZ CO., Philadelphia, Pa. Silicate of soda. In charge of exhibit, James G. Vail, Edward Quintard, W. H. Buxton, J. B. Mercier.

PNEUMERCATOR CO., INC., New York. Indicating instruments for measuring depth, weight or volume of any liquid contained in any tank, stand pipe or reservoir. Instrument can be located at any distance from tank. Displacement indicator for ships, automatically indicating cargo and displacement. Gasoline gage for automobiles or aeroplanes. In charge, A. C. Kohl.

PRATT ENGINEERING & MACHINE CO., Atlanta, Ga. Regulus metal and aluminium exhausters for handling corrosive gases. Acid valves and blow boxes. Photographs of various sulphuric and fertilizer plants designed, constructed and equipped by exhibitor. Photographs of standard machinery and apparatus for chemical and fertilizer plants. In charge of exhibit, C. A. Murphey.

PRECISION INSTRUMENT COMPANY, Detroit, Mich. Boiler control apparatus. 1. Complete gage board for boiler control, having two 3 in 1 gages indicating the draft through the ashpit, combustion chamber, flue before the economizer, after the economizer, and the last pass; steam gage indicator, steam gage recorder, CO_2 recorder, steam flow meter, flue gas temperature recorder, rheostat control valve, remote control switches. 2. Gage board showing complete line of "U" gages, 2 in 1 recorder, 2 in 1 indicator, combined indicating and recording differential gage. 3. CO_2 analyzing machine for recorder on the board. 406C CO_2 recorder, standard type. 4. Gas collector, Orsat type, efficiency kit. 5. Chemical lamp blown glassware. In charge of exhibit, A. T. Baldwin, pres. and mgr., Detroit; Vincent & Gibson Engineering Corp., 30 Church St., New York City.

PRECISION THERMOMETER & INSTRUMENT CO., Philadelphia, Pa. Precision engineer type separable socket thermometer for power and process plants, built to meet the specifications of the Bureau of Steam Engineering, U. S. N. Technical thermometers of all descriptions, thermometers for laboratory and research work, thermometers and hydrometers for acid manufacturers. Pentane and toluol thermometer, made in Philadelphia, for low temperatures. Toluol to minus 100° C.; Pentane to minus 200° C. Precision Le Boulengé chronograph for determination of muzzle velocity of a projectile. Precision calender micrometers, indicating and recording. Standard mercurial barometer, built to U. S. Government specifications. Meteorological instruments. Precision hydrometer for all purposes. In charge of exhibit, Lewis G. Wilson, L. L. Stewart, H. L. Balderston.

PREST-O-LITE CO., Indianapolis, Ind. Gas tanks and appliances, acetylene, welding outfits, etc.

PROCESS ENGINEERS, LIMITED, Montreal, Canada. Model showing a complete installation for diluting rosin sizes, soluble oils and other emulsifying materials. Also a working-size emulsifier and samples showing the permanent character of solutions produced by this process. In charge of exhibit, J. A. DeCew, H. A. Radford and Robert B. Best.

PRODUCTS SALES CO., Baltimore, Md. High acid resistant asbestos and industrial minerals. In charge of exhibit, H. Hanna, F. A. Nielt.

PROVOST ENGINEERING CO., New York. Provo metal and wooden filter presses.

PYROLECTRIC INSTRUMENT CO., Trenton, N. J. Pyrometers and electrical precision instruments. Considerable attention was drawn to the Northrup-Ajax high frequency induction furnace, which was developed by E. F. Northrup for and with the financial support of the Ajax Metal Co. of Philadelphia, Pa. The new Northrup tin pyrometer also attracted great attention.

QUIGLEY FURNACE SPECIALTIES CO., New York. Demonstration of hytempite furnace cement, showing its heat-resisting qualities.

RAYMOND BROS. IMPACT PULVERIZER CO., Chicago, Ill. Exhibited pulverizing and air-separating machinery used for producing fine ground materials of all kinds. Also exhibited a few air-separated products; that is, samples of materials as they are fed to air mills and the powdered material produced. The Raymond System is a complete unit for taking materials around one-inch size and reducing them to a powder having any fineness desired and in one operation. It takes the place of grinding, elevating and screening machinery and is dustless in operation. In charge of exhibit, C. M. Lauritzen, vice-pres. and mgr.; W. M. Cook, Joe Criter, W. A. Koren.

RESEARCH CORPORATION, New York. Display of high-voltage, direct-current, generating equipments. 1. Mechanical rectifier. 2. Kenotrous (General Electric Co.). 3. Girvin high-voltage, direct-current generator. Demonstration Cottrell collector for smoke fume and dust. Display of samples of materials. Precipitated by the Cottrell electrical precipitation processes. In charge of exhibit, H. D. Egbert, commercial department; P. E. Landolt, engineering department.

RESEARCH LABORATORY OF CHICAGO. Pharmaceutical chemicals, dyes and intermediates, the processes for the manufacture of which have been developed in their laboratory. Among the products exhibited are methylene blue, dye and medicinal; phenacetin, phenolphthalein, dimethylglyoxime, para amido phenol, para nitro phenol, malachite green, benzoic acid, beta naphthol benzoate, benzoyl chloride, hydroxylamine hydrochloride and ethyl nitrate. In charge of exhibit, H. McCormack, S. W. Kendall.

THE ROESSLER & HASSLACHER CHEMICAL CO., New York. Showed sodium cyanide, 96 to 98 per cent, cyanide-chloride mixtures—copper cyanide, silver cyanide and zinc cyanide for plating; also the plating salts, silver, copper, zinc and gold trisalyt. In charge of exhibit, William J. Schneider.

RUGGLES-COLES ENGINEERING CO., New York. Model of double-shell, direct-heat dryer. A working duplicate of regular machines. In charge of exhibit, F. E. Finch, W. H. Glomb.

RUTH FLOTATION MACHINE CO., Denver, Col. Ruth testing machine for laboratory testing purposes. Exact duplicate of commercial machine. Joseph P. Ruth, Jr., in charge.

SCHAAR & CO., Chicago, Ill. Laboratory apparatus, chemical glassware, "Hexagon" oil tester, "Hexagon" heater, "Hexagon" Harvard trip scale. Universal electric heater. All standard makes of glassware, porcelain, filter paper, etc. Adolph E. Schaar in charge.

THE SCHAEFFER & BUDENBERG MFG. CO., Brooklyn, N. Y. Indicating gages and recording gages, gage testers. Indicating thermometers of all types, recording thermometers. Counters of all types. Indicating, portable and recording tachometers. In charge of exhibit, R. Wimmers, A. Weiss, F. Undeutsch.

SCHAUM & UHLINGER, INC., Philadelphia, Pa. Cantilever suspended bottom-discharge centrifugal dryer.

SCHUTTE & KOERTING CO., Philadelphia, Pa. Apparatus for handling acids and other chemical liquids, gases and vapors; comprises lead valves, lead-lined valves, lead exhausters, both with water and steam as the motive power. Double tube injectors, steam syphons, various types of spray nozzles and spray equipment. The Bihn Jones automatic apparatus, air jet lifts, and a full line of oil-burning equipment, heaters, etc. In charge of exhibit, C. H. Kimberly and J. S. Patten.

SCIENTIFIC EQUIPMENT CO., New York. Exhibiting the apparatus made by Central Scientific Co. of Chicago, de Khotinsky constant temperature baths and ovens, balances, air pumps, rheostats, American glass and porcelain ware, and the laboratory furniture of the Kewaunee Mfg. Co., makers of chemical desks, hoods, cabinets, etc. In charge of exhibit, O. T. Louis, S. L. Redman, Chas. Ress, C. G. Campbell

ERNEST SCOTT & CO, Fall River, Mass. Chemical process machinery, photographs of installations.

SEYDEL MFG. CO., Jersey City, N. J. Textile sizings, benzoic acids, fur colors and special chemicals.

SHARPLES SPECIALTY CO., Philadelphia, Pa. Several types of centrifugal machines.

SHRIVER & CO., Harrison, N. J. Shriver standard filter press and Atkins-Shriver type O patented filter press.

SIDIO COMPANY OF AMERICA, New York. Fused silica tubes, coils, crucibles, concentration dishes and special apparatus.

JOHN SIMMONS CO., New York. Steam and mechanical specialties. Leinert automatic gravity scales for liquids. Acid-proof valves and high pressure fittings.

WALTER SODERLING, INC., New York. Dustite respirator.

SOUTHERN RAILWAY SYSTEM. Mineral and chemical resources of the South, manganese ore, bauxite oils, tars, talc, soapstone, barite, raw and finished products. In charge of exhibit, J. H. Watkins, W. C. Olds.

SOWERS MFG. CO., Buffalo, N. Y. Seamless one-piece jacketed kettles, vacuum pans and mixers.

E. R. SQUIBB & SONS, New York. Organic and pharmaceutical chemicals.

STAMFORD EXTRACT MFG. CO., New York. Samples of logwood extracts and yarns and leathers dyed by these dyes.

ST. GEORGE CHEMICAL CO., New York. Rubber, paper and leather, manufacturers' chemicals, antimony, sulphide, heavy calcined magnesia, whiting and various colors. In charge of exhibit, J. G. Smith, H. C. Bugbird, D. S. Naugle, R. J. Parkellt.

ST. LAWRENCE TALC CO., New York City. Talclay for obtaining vitrified bodies at a lower cone, using 5 per cent with regular body mix.

STEVENS-AYLSWORTH CO., New York and Toronto. Demonstration of agitators and mixers for liquids and dry products. In charge of exhibit, Messrs. R. G. Stevens, W. N. Stevens, R. P. Alysworth

F. J. STOKES MACHINE CO., Philadelphia, Pa. Pharmaceutical and chemical machinery and apparatus. Tablet making machine in operation. Vacuum drying machinery, automatic water still, etc. In charge of exhibit, Lawrence H. Bailey, Charles F. Coleman.

STUEBLING LIFT TRUCK CO., Cincinnati, Ohio. Factory trucks.

STURTEVANT MILL CO., Boston. Crushing, grinding, pulverizing, screening, mixing (dry), weighing and sacking, and elevating machinery. In charge of exhibit, L. H. Sturtevant, H. A. Tomlinson, W. T. Doyle, D. Kantor, H. P. Withington.

SWENSON EVAPORATOR CO., Chicago, Ill. "The sign of the kettle."

TAKAMINE LABORATORY, INC., New York. Polyzime "T" and "L", Japanese chemicals, potash, salts.

TAYLOR INSTRUMENT CO., Rochester, N. Y. Tycos recording thermometers, industrial indicating thermometers, pyrometers, and temperature regulators. A new development was shown in the Tycos multipyrograph for recording six different temperatures on one chart, employing only one galvanometer. In charge of exhibit, H. W. Maurer, James Ely, A. J. Nelson, H. W. Kugler, D. C. Day, Jr., Fred K. Taylor.

TENNESSEE COAL, IRON & R R. CO. Iron ore and by-products. Coal and by-products.

THE TEXAS CO., New York. Petroleum products.

TEXAS, STATE OF. Petroleum and its products, mica, minerals, sulphur. In charge of exhibit, F. E. Pye, W. D. Bettis, Seaton Keith, J. R. McNeil, Milton Everett, H. L. Hargrove.

TEXTILEATHER CO., New York. Textile leather substitutes.

TEXTILE COLORIST, Philadelphia, Pa Reception booth Library of bleaching, dyeing and finishing.

TEXTILE WORLD JOURNAL, New York. Bragdon, Lord & Nagle Co., Textile Publishing Co. Reception booth.

THE THERMAL SYNDICATE, LTD., New York. This display covered vitreosil (fused pure silica) concentration, condensation and cooling plant for sulphuric, nitric and hydrochloric acids, etc., also laboratory ware, drawn tubes, moulded pipe and other forms of apparatus for the chemical and allied industries. The exhibit included retorts of 75 and 50 litre capacity, tubes 4½ in. and 4¼ in. internal diameter, pipe 15 in. internal diameter and "S" Bend coolers 8 in. internal diameter. Special attention was called to the installation at the Davison Chemical Company plant, Curtis Bay, Maryland, where the final concentration of 180 tons of sulphuric acid daily is carried out exclusively in Vitreosil units. In charge of exhibit, E. A. Haynes, S. L. Tyler, E. J. Van Vranken, W. W. Winship.

THWING INSTRUMENT CO., Philadelphia, Pa. High resistance, multiple record pyrometers.

TOCH BROTHERS, New York. DUREX CHEMICAL CO., Sweetwater, Tenn. Technical paints, water proofing compounds, damp proofing paints, enamels, cement colors, rust inhibiting and protective paints, varnishes, chemical dryers and Japans. Barium products of all kinds, colors, chemicals, etc. In charge of exhibit, Archibald C. Reid, advertising manager; G. H. Benkhardt, sales manager; V. P. Krauss, fectory superintendent.

TOLHURST MACHINE WORKS, Troy, N. Y. Several interesting types of centrifugal machines.

TRADE NEWS SERVICE, New York. Reception booth.

UEHLING INSTRUMENT CO., New York. Uehling CO2 recorders for increasing combustion efficiency, and other instruments.

UNITED FILTERS CORPORATION, Brooklyn, N. Y. One American continuous suction filter in actual operation, showing cake building characteristics and method of discharging solids. One Sweetland filter in actual operation, showing filtering characteristics of Sweetland's Patent Metallic Cloth. Small practical units of Kelly type filter and Sweetland Clam Shell type filter also on exhibition. Complete line on all the various types of filter leaves and filter cloths furnished by the U. F. Co. on hand. In charge of exhibit, Arthur Wright, H. J. Runyon, Jr., T. L. Geuter, H. W. Schmidt, M. J. Jackson, R. Cottrell.

UNITED GAS IMPROVEMENT CO., Philadelphia, Pa. Samples of coal tar product, tar naphthalene, sulphate of ammonia, phthalic anhydride, etc.

UNITED LEAD CO., New York. "United" lined acid pipe and fittings.

U. S. CAST IRON PIPE & FOUNDRY CO., Burlington, N. J. Display of "Usicast" chemical castings and U. S. cast-iron pipe. Included a cast-iron pipe line showing various thicknesses and types of joints of U. S. cast-iron pipe. Also several reproductions of "Usicast" equipment. H. A. Hoffer of the chemical castings department in charge.

U. S. DEPT. OF AGRICULTURE. Fertilizers and photographs of processes.

UNITED STATES MAGNESITE CORPORATION, New York. Showed magnesite from their mines in California and Washington and ranging through the different manufactured products, such as caustic magnesite, dead burned magnesite, ferromagnesite, down to the common Epsom salts, also a product of magnesite. Also showed a new polish for all kinds of metals, glass, etc. In charge of exhibit, F. E. Schundler, Karl K. Kennedy, George H. Nielson.

U. S. SMELTING CO., INC. Commercial samples of lead, electrolytic, common and antimonial, copper, spelter, electro and high grade, selenium, cadmium, bismuth, arsenic. Full size gold and silver bars. Platinum and palladium. A new departure in exhibits in that the arrangement of shelves and equipment is permanent and the property of the exhibitor. The whole can be removed from place to place. A beautiful example of bismuth crystals shown. In charge of exhibit, Sidney Rolle, Don Irions, B. B. Hood and Joseph Clark.

UNIVERSAL FIBRE CO., Trenton, N. J. Fibre barrels.

VALLEY IRON WORKS, Williamsport, Pa. Reception booth.

H. VAN EMDEN & CO., New York. Tanks, pans, stacks, kettles and plate work. Quick delivery. Sales agencies In charge of exhibit, H. Van Emden, M. I. Dorfan.

VISCAMITE CO., New York. Samples of viscamite, a

patented vegetable glue for all purposes where animal glue is used.

WALLACE & TIERNAN CO., INC., New York. Demonstration of chlorine diffusor in operation. Exhibit of chlorine control apparatus.

WAL PHOTO CO., New York. Official photographer of the exposition.

WARNER CHEMICAL CO., WARNER-KLIPSTEIN CHEMICAL CO., New York. Exhibit, Nelson electrolytic cell. Chemicals: Acetic anhydride, acetyl chloride, acid phosphoric, aluminum hydrate, calcium phosphate monobasic, carbon bisulphide, carbon titrachloride, phosphorus trichloride, pnosphorus oxychloride, soda caustic liquid, soda caustic solid, sodium phosphate monobasic, 100%, sodium phosphate monobasic pyro, sodium phosphate dibasic com'l, sodium phosphate dibasic U. S. P. tran., sodium phosphate dibasic, U. S. P. anhyd., sodium phosphate tribasic, sulphur chloride.

WARREN, WEBSTER & CO., Camden, N. J. Metering Feed Water Heater. The apparatus shown in actual operation is the well-known Webster-Lea heater meter. It consists of a standard Webster open feed water heater combined with a genuine Lea V. Notch Weir meter to form one unit. The outstanding features are that heater and meter are independent units, so arranged that either can be operated independently or in combination as desired. The flow of water to the meter is controlled by a float-actuated valve in strict accordance with boiler feed requirements, so that the meter cannot flood. Extra large pump storage is provided. Webster oil and steam separators, expansion joints and heating system specialties are also shown. In charge of exhibit, W. F. Bilyeu and G. A. Binz.

WELDING SUPPLY CO., New York. Welding and cutting apparatus, oxy-acetylene, oxy-thermalene, thermit electric welding apparatus.

WERNER & PFLEIDERER CO., Saginaw, Mich. Universal kneading and mixing machines for chemical and allied industries. Photographs of installations.

WESTINGHOUSE ELECT. & MFG. CO., East Pittsburgh, Pa. This company exhibited apparatus of their line that is used in the chemical industry. This includes motors, starters, oil switches, circuit breakers, meters and transformers. A line of laboratory apparatus is also shown. This includes electric stoves, hot plates, water heaters, fans and air purifiers. A number of Bakelite Micarta gears are shown. Bakelite Micarta is the only non-metallic gearing material that is self-supporting and in most cases neither bushings nor flanges are needed. A Thury regulator is shown. This regulator regulates the temperature of electric furnaces automatically.

WEST TEXAS MICA CO., Houston, Texas. Mica products.

WHITALL-TATUM CO., New York. Chemical glassware and rubber goods. In charge of exhibit, W. W. Figgis.

WILLIAMSBURG CHEMICAL CO., INC., Brooklyn, N. Y. Sulphur black, malachite green, auramine, benzyl chloride, benzol chloride, benzaldehyde, benzoic acid, U. S. P., benzoate of soda, U. S. P., dinitrochlorbenzol, permanganate of soda. In charge of exhibit, Charles L. Hirsh.

ZAREMBA CO., Buffalo, N. Y. Reception booth and photos of Zaremba evaporators.

Industrial Handicaps in Switzerland

The Department of Commerce has issued a bulletin covering the industrial situation in Switzerland, which gives interesting information regarding the effect of the war upon Swiss chemical and metallurgical industries during the last year.

COAL SUPPLY AND PRICES

The shortage in the coal supply became manifest in September, 1916. A committee, with its chief office in Basel, was established to arrange for fuel from Germany and the occupied Belgian districts. An agreement was reached by which Switzerland was to receive 253,000 metric tons of coal and coke monthly—50,000 for railways, 7,000 for sidings, 51,000 for gas works, and 145,000 for domestic and industrial purposes; but in reality the full quantity agreed upon was never delivered.

The retail prices of fuel per metric ton steadily rose from $12.50 in January to $17.25 in December for Belgian coal, while coke increased from $11.20 to $16.60.

RAW MATERIAL FOR SWISS METAL INDUSTRIES

In 1916 material improvement was shown in the Swiss metal industries. The various orders placed with Swiss firms were carried out with fewer difficulties and, owing to the absence of German competition, prices for the finished products were satisfactory. Machine tools were in heavy demand.

Through a commercial agreement with Germany, Switzerland hoped to relieve its economic difficulties, but did not succeed because German consignments of steel and iron were long delayed, despite contracts for immediate delivery. Representatives then obtained satisfactory supplies from the United States, but many transportation handicaps were experienced. The prices per short ton were:

	Dec., 1916	Normal Price
Scrap iron	$70-$88	$12-$14
Steel	$122-$176	$32-$39
Pig iron	$35-$53	$12-$14

The German Steelworks Association, through a central office, canceled the mark currency, fixed a standard for the franc, and voided Swiss contracts causing a 60 per cent price increase. No pig iron could be imported from Germany from July to November, when the United States became the principal country of supply. Tin came from Germany until June, 1916, after which shipments declined and prices increased 300 per cent. The price of electrolytic copper advanced from 24½ cents in January to 38 cents in July, receding to 33½ cents in December.

The manufacturers of ammunition depended entirely upon the country's resources for acids, which were hardly sufficient. The fair supplies of hydrochloric, sulphuric, and nitric acids relieved the shortage of other materials and kept the factories in operation.

ANILINE COLORS AND ARTIFICIAL INDIGO

There was a decrease in aniline exports to the United States in 1916 amounting to 6 per cent, and an increase in value of 113 per cent. This was due to the general advance in prices and to the exclusive shipment of the finer and more expensive colors. The progress made in the American color industry practically excluded the lower grades of Swiss dyes from that market. Anxiety was felt in Switzerland concerning the future trade in Swiss colors with both the United States and England. The belief that those countries would not be able to produce aniline dyes was disproved. Since 1914 dye factories have also been built in France, Italy, and Russia. It became more and more difficult in 1916 to obtain necessary raw materials from England and the United States. The Swiss manufacturers are now preparing to withstand the apparently concerted effort of German color manufacturers to undermine them.

The quantity of artificial indigo exported to the United States in 1916 declined by 212,521 pounds, but was valued at $150,229 more than that shipped in 1915. That there was an actual increase in value is unlikely, but the new tariff law making this color dutiable compelled the manufacturers to state the market value, whereas formerly, under free entry, they gave only nominal values in their invoices. The decrease in quantity should probably be attributed to the activity of the British firm of Elesmer Port.

The Russian Market, Its Possibilities and Problems

By A. J. Sack
Director, Russian Information Bureau.

The present war and the Revolution undoubtedly opened a new era in Russian industrial development, and there is no question but that by a proper and active policy the United States will share largely in this development in Russia.

Russia needs the help of American capital and business enterprise in her economic development. The United States, with a surplus capital and with a steadily increasing industrial production, requires the immensely large Russian market as an outlet for its trade and its investment. The two countries are in a splendid position to supplement their respective economic requirements.

The present war has created many changes in the prospects for the development of a close economic co-operation between Russia and the United States, but even prior to the war there is strong evidence showing the tendency toward economic co-operation between Russia and the United States. The changes effected by the present war are therefore only an emphasized continuation of the natural tendency toward an American-Russian economic rapprochement.

The United States export to Russia always has been greater than Russia's export to the United States. By comparing the Russian and the United States statistics referring to the United States export, the following table is obtained:

Years	U. S. Export to Russia According to U. S. Statistics	U. S. Export to Russia According to Russian Statistics
	(Yearly average in millions of dollars)	
1878-1890	11.9	15.5
1891-1900	7.5	22.0
1901-1910	16.7	28.3
1911-1913	25.4	42.3

In this table preference must be given to the Russian statistics. A great part of the goods en route from the United States to Russia was frequently reloaded in west European ports and therefore appeared in the United States statistics as export to Germany, Great Britain or Holland. "The United States is playing a greater part in our trade," says the official report of the Russian Ministry of Finance, "than can be seen in our statistical reports. The real amount of our trade with the United States is not obvious, on the one hand, because of our undeveloped direct trade relations, and on the other hand, because of the middleman's part, played until now by Germany and Great Britain."

This official Russian statement can be reversed to interpret the American side of the situation. Russia is playing in the United States trade a considerably larger part than can be seen in United States statistics.

The two countries have need of one another, and, therefore, trade between them developed even under the most adverse circumstances. It is impossible to say what was the real amount of American-Russian trade, but assuredly considerable quantities of Russian goods were successfully brought into this country and great quantities of American goods were successfully brought into Russia.

GOODS NEEDED IN THE UNITED STATES IMPORTED FROM RUSSIA

Russia supplies the United States almost exclusively with raw materials. In 1910 Russia's entire export to the United States, according to Russian statistics, amounted to 4.84 million dollars. Of this, 4.69 million dollars—about 97 per cent—was raw materials. Such products as hides and skins, wool, horse manes, horse tails and bristles hold first place among these exports. Russian statistics accredit these goods with a yearly average of 2.22 million dollars for the period 1906-1910 out of 3.82 million dollars of Russia's entire export to the United States.

Second place should be given to licorice root. It is of interest to observe that the United States is almost the sole market for Russia's licorice root. In 1910, out of 29.24 million pounds of Russia's total export of licorice root, 27.73 million pounds were exported to the United States.

Besides the products mentioned above, it is necessary to call attention to Russia's export of rubber waste, manganese ore, flax and hemp. According to United States reports, the export of these goods to the United States was greater than the Russian statistics show. During the period 1906-1910 the United States import of rubber waste averaged 4.83 million pounds, according to Russian statistics, and 6.53 million pounds according to the United States reports. As for manganese ore, Russia reported 24.3 million pounds and the United States reported 30.4 million pounds. The most noteworthy difference is found in the statistical reports relating to Russia's export of flax and hemp. According to the Russian statistics, the yearly average of Russia's flax exported to the United States during the period 1906-1910 amounted to 481,100 pounds. According to the United States statistics, it amounted to 6,786,000 pounds. The corresponding figures for hemp are 241,800 pounds in Russian statistics.

According to the statistics of both countries, therefore, during the ten years previous to the present war there has been a remarkable increase in the exportation to the United States of Russian raw materials consisting chiefly of licorice root, hides and skins, furs, hair and bristles, wool, hemp, horses' manes, horses' tails, pulp and rubber waste. The American statistics show also that a considerable amount of flax and flax tow must be added to this list.

During the war, on account of the restrictions placed by the Russian Government on the movement of Russian raw materials to the United States, it has been difficult to secure a free importation from Russia to this country. There has been, however, a very steady increase in the demand for Russian raw materials of all kinds. This is particularly true of furs and fur skins, of hides and skins, especially calf skins and goat skins, and also of Russian seeds. A typical illustration is the fact that prior to the war the United States purchased most of its sugar beet seed for planting purposes in Germany. Germany in turn secured the bulk of this seed from Russia. Since the war direct relationships have been opened and the United States has imported large quantities of Russian sugar beet seed. Careful estimates show that there is a market demand in the United States for from 60 to 75 million dollars' worth of Russian raw material, which forms a nucleus for a

large reciprocal trade with America, and to some degree discounts the idea that the trade between the United States and Russia is not supplemental in nature.

GOODS NEEDED IN RUSSIA IMPORTED FROM THE UNITED STATES

As to the United States export to Russia, there is again a great difference in the Russian and the United States statistics, relating not only to trade totals, but to individual articles of trade.

Cotton holds first place in the United States export to Russia. It has been noted before that the amount of cotton exported to Russia by the United States in 1910, according to statistics on this side, was 38.89 million pounds, whereas Russia reports 164.95 million pounds. And undoubtedly, even Russian statistics do not cover the entire amount of cotton coming originally from the United States.

Machinery and technical supplies hold second place in the United States export to Russia. And here special mention must be given to agricultural machinery and implements. During 1901-1905, according to Russian statistics, the entire United States export of machinery to Russia amounted to 3.23 million dollars, yearly average; of this 2.73 million dollars covered the United States export of agricultural machinery and implements. Reports for the period 1906-1910 give 4.94 million dollars as the entire machinery export, of which 4.43 million dollars covers the export of United States agricultural machinery and implements to Russia.

It is interesting to note that in the United States statistics relating to the export of agricultural machinery and implements to Russia, larger figures are given than those above. Reports on this side give 3 million dollars as the annual average for the period 1901-1905, as against the 2.73 million dollars quoted by the Russian reports. Corresponding figures for the period 1906-1910 are 5.17 million dollars, according to American statistics, and 4.43 million dollars, according to Russian reports. For 1913 there is 5.31 million dollars according to the United States statistics and 4.7 million dollars according to Russian reports. It is natural to expect the Russian figures to be higher than the American, because the Russian estimate is a combined estimate of the price in the American port plus freight, insurance, loading expense, and even often including the profit of the west European middleman. The report of the Russian Ministry of Finance explains the situation very clearly. "Part of the American machinery," says the report, "after being reloaded in Germany, England or Denmark, is registered in our statistics as coming from these countries and not from the United States."

The same may be said about copper, which holds third place among the goods imported in Russia from the United States. According to Russian statistics, the United States copper imported averaged yearly 8.88 million pounds during 1901-1910. On the other hand, according to the United States statistics, the amount was 18.52 million pounds. It is seen that the amount of United States copper that entered Russia, according to American statistics, was more than double the amount given in Russian reports. The Russian Ministry of Finance gives again a very definite explanation of the situation. "We receive United States copper," says the report, "through Germany's and Great Britain's hands."

A remarkable discrepancy occurs further in the statistics relating to United States flour imported in Russia. According to Russian statistics, the yearly average import of United States flour of every kind, excluding potato flour, during the period 1906-1910 amounted to 15.7 million pounds. On the other hand, according to the United States statistics, the yearly average export to Russia of only wheat flour for the same period amounted to 75.81 million pounds. The flour is exported mostly to Finland, and because of the lack of direct connections with the United States it is registered in Finland as brought from Germany. This fact has been mentioned more than once even in the German official reports.

The following table shows the growth of the United States export to Russia before the war, according to United States statistics:

U. S. Yearly Average Export to Russia (In Thousands of Dollars)

	1891-1895	1896-1900	1901-1905	1906-1910	1911-1913
Cotton (raw)	4,811.0	3,006.0	5,909.0	5,478.0	5,685.5
Agricultural machinery and implements	323.4	684.4	3,000.0	5,178.0	7,729.7
Copper (unmanufactured)	....	822.0	1,632.0	1,112.0	1,322.7
Wheat flour	136.0	395.0	773.0	1,895.0	3,360.0*
Leather (prepared)	....	1.3	1.8	162.0	1,075.3**
Machine oil and paraffin	1.8	9.1	71.1	151.2	232.8**
Rosin	241.0	285.0	275.0	320.0	737.0
Typewriters	....	126.1	172.7	367.8	846.9
Cash Registers	....	....	26.0	124.0	249.4**
Sewing machines	....	28.1	36.3	232.9	768.2**
Scales of every kind	29.4	70.5	54.0	57.0	58.6**
Twine, cord, etc.	11.7	28.5	299.9	753.0	1,646.4

The figures just quoted, together with the figures quoted previously regarding Russia's export to the United States, show quite clearly along what lines the American-Russian trade rapprochement had begun to develop even before the war, before the remarkable changes produced in the economic situation of both countries.

Russia supplies and will supply this country with raw materials of the highest quality. The amount of Russian raw materials brought to this country is much greater than can be seen from Russian or even United States statistics. By creating direct connections with Russia, by careful study of the conditions of the Russian market, by an active trade policy, the amount of raw materials brought to the United States from Russia can be multiplied many times to the benefit of both countries.

On the other hand, the United States supplied and will supply Russia with all kinds of machinery, with all kinds of products that presuppose a highly developed industrial culture. The possibilities of such trade, very apparent before the war, are emphasized by the events of the war. Germany, which in 1913 held 52.6 per cent of all Russia's import, is now withdrawn from the field. By proper and active policy the United States can now not only develop that line of her trade with Russia that showed a natural tendency to develop before the war, but even introduce into the Russian market a full line of goods never before brought into Russia from the United States. It is indeed, a big opportunity.

Woolworth Building,
New York City.

* This is the figure for 1911. No figures are given for 1912 or 1913.

** Figures for 1913.

Production of Potash During First Six Months of 1917

More potash has been produced during the first six months of 1917 than was made during the entire year 1916. The reports received by the U. S. Geological Survey have been reduced to terms of the commercial unit commonly used to measure the available or water-soluble potash (K_2O) in the product, and only material actually sold by the producer during this period is included. The weight of the materials handled was therefore much greater than represented by these figures.

SUMMARY OF THE PRODUCTION OF POTASH IN THE UNITED STATES, JANUARY TO JUNE (INCLUSIVE), 1917

Source	Available Potash (K_2O)	Value at Point of Shipment
	Short Tons	
Natural salts or brines	7,749	$2,808,240
Alunite and dust from cement mills and blast furnaces	1,867	746,576
Kelp	2,143	1,348,095
Distillery slop, wool washings, and miscellaneous industrial wastes	2,153	876,714
Wood ashes	a111	84,414
	14,023	$5,864,039

aOnly 25 reports of production from wood ashes having come in, some of the larger producers not having made returns.

This table includes practically all potash produced.

The Nebraska alkali lakes still lead, having yielded about one-third the entire production. There are now at least four important operators in this field.

The production from Searles Lake, Cal., would undoubtedly be materially assisted by passage of the legislation now before the House of Representatives dealing with the leasing of potash-bearing lands. Continued uncertainty as to the status of titles to this property has hampered development of this important deposit.

No production is reported from feldspar or other silicate rocks, but considerable quantities of potash salts and potash-bearing fertilizers were obtained from the dusts in cement mills and blast furnaces.

The production from kelp was about 15 per cent of the total, as it was in 1916.

Potash from distillery slop and other organic sources made 15 per cent or more of the total.

The production of potash from wood ashes, including "first sorts," "pearlash," and other grades, is supposed to have been much greater than it was in 1916, but reports from these producers have been much delayed and the figures obtained thus far are probably not representative. The potash made from wood ashes thus far reported amounted to 222 tons, which is assumed to average at least 50 per cent K_2O. This is perhaps too low, but definite information as to the grade of this material is difficult to obtain.

The prices quoted range from $3.50 to $6 a unit, a unit meaning 1 per cent of potash (K_2O) in a ton of the material as marketed—that is, a product carrying 25 per cent K_2O may be sold at $4 a unit, which would be $100 a ton for the material marketed.

The figures given seem to indicate that the production for 1917 will exceed 25,000 tons of potash (K_2O), or two and one-half times that made in 1916. This is about 10 per cent of the average normal yearly consumption of the country before the war, showing the need of further stimulating domestic production of potash.

Potash from Alunite

Fertilizer containing water soluble potash is being made from Utah alunite at the present time by the Mineral Products Co., St. Marysvale, Utah, who, together with the Utah Potash Company, were among the first to investigate the possibilities of the production of potash from alunite.

Roasted alunite can be used direct as a fertilizer, in fact, raw alunite also can and has been used. Roasting increases the potash content to about twice that of the unroasted material, by driving off the sulphur, hence a great saving in freight is made by roasting.

The Utah Potash Company is planning to go further than roasting alunite, and has built a factory at Trenton, N. J., where a wet process will be carried out, producing refined potassium nitrate or other potassium salts, together with various by-products. The alunite will be brought in from Utah where considerable money has been spent in development work on the company's alunite deposits near Marysvale. The average potash content (K_2O) is 7 to 10 per cent. An analysis of the alunite made by Dr. H. J. Detwiller of Allentown, Pa., is as follows:

Silica	2.91
Alumina	35.32
Sesq. Ox. Iron	1.99
Phosphoric Acid	40
Sulphur Anhy.	37.86
Potash	10.85
Soda	26
Water	9.99

The material is brought in in sizes up to 12 inches. It is first put through a Blake style crusher from which it goes to a 10 or 12-inch traveling belt and from there to two Moser mills where it is reduced to $\frac{1}{2}$ x $\frac{3}{4}$ inches. It is then elevated to three Griffin mills where it is ground to 100 mesh. From there it is elevated to a bin, and then delivered to leaching tanks as needed. The tanks are used in series of three. In the first tank it is digested with water and acid, being heated with live steam. All of the material dissolves but the silica.

After filtering, the liquid is run into the second tank where the alumina is precipitated with an alkali potassium compound. The filtrate from the second tank goes to the third tank where the sulphuric acid is precipitated with barium carbonate, giving barium sulphate. The remaining solution containing the potash is then evaporated and the potassium nitrate crystallized out. The mother liquor is used over again.

The company will concentrate a great deal of attention on by-products when the process is in satisfactory operation. Some of the possible products are silicate of soda, alum, aluminium, barium salts, etc. The process has been worked out by Dr. H. J. Detwiller, consulting chemist, of Allentown, Pa., and Mr. T. F. Taylor, treasurer and mechanical engineer of the company.

Iron Ore in 1916.—The iron ore mined in the United States in 1916 reached a total of 75,167,672 gross tons, the greatest annual output ever made, according to the U. S. Geological Survey. The shipments from the mines in 1916 were 77,870,553 gross tons, valued at $181,902,277. The quantity mined in 1916 was more by 19,600,000 tons than that mined in 1915.

Synopsis of Recent Metallurgical and Chemical Literature

Metallurgical Industries at Birmingham, England.—At the annual meeting of the Society of Chemical Industry in Birmingham, England in July, Prof. T. TURNER of the University of Birmingham, reviewed the progress of the local metallurgical industries at Birmingham, during the war. Closely associated with the production of coal and iron in this district is the supply of refractories, and the manufacture of copper, brass, nickel, aluminium, and other metallurgical materials. He said the production of iron and steel in the Staffordshire district is limited by the moderate supplies of ore in an inland center. The output is, however, by no means negligible, and is equal to that of the whole of the United Kingdom a century ago. The basic process of steel manufacture is that which is chiefly followed, and the open-hearth furnace is taking the leading place here, as in other centers of the steel trade. The wrought iron trade, though much smaller in volume than in its palmy days, still flourishes, and all the local works have been fully employed at remunerative prices. The blast furnaces produce foundry forge and basic pig irons; the maximum output has been maintained, and it is proposed to put additional furnaces in blast.

In the brass and copper industries there has been unprecedented activity. Though no new scientific discoveries have to be recorded, many improvements have been introduced into works practice. Incidentally reference may be made to the extended use of town gas for melting purposes, with resulting increase of speed and economy. Tilting furnaces are now much more used than was formerly the case. An important local industry is that of cartridge manufacture. The results of researches conducted in the University of Birmingham, by Dr. O. F. Hudson, have been found of considerable value to local manufacturers, particularly in connection with the annealing of metals, and the composition and treatment of certain brasses which have recently had an extended application.

The local nickel industry has been taxed to its utmost capacity; not only has there been the unprecedented demand for cupro-nickel, but the nickel silver trade has been by no means idle, while there has been a demand for pure nickel goods such as were formerly imported from the Continent.

Professor Turner said that in no direction has there been greater expansion than in the aluminium industry. There are now several large aluminium foundries in the city, and the output of only one of these would be equal to that of the whole world a dozen years ago. The product has been largely used in connection with munitions of war, as in certain parts of shells; in aeroplane construction, and for many other purposes where strength and lightness are desired. The metal is now very generally melted by means of town gas as fuel. This has been found to be cheap, clean, and convenient. Melting is performed either in graphite crucibles, or very commonly in cast iron pots, which are preferably protected by a wash of inert material. Pure aluminium is very seldom used; the alloying metals include zinc, copper, and occasionally tin, nickel, manganese, or other metals. Researches in the properties of these alloys have been conducted, and so far as opportunities permit, are still in progress in the University laboratories.

Recently special attention has been drawn to the production of malleable cast iron, which is an industry which has long been associated with Walsall, Birmingham, and the intermediate district. There are at present some 90 firms engaged in the local trade, and many of these conduct their business on a relatively small scale. The process generally followed is the Réaumur, or European method, of more or less complete oxidation of the carbon, as contrasted with the American or "Black heart" process in which the carbon is precipitated as fine grained, or secondary, graphite. For the production of this malleaable cast iron the raw material employed is obtained from pure hematite ores, as it is usually considered to be important to have metal which is low in phosphorus and manganese. The demand for specially pure ores for other purposes has led to attention being directed to the question as to how far other materials can be employed to replace the purer cast iron hitherto used. It is known that good material can be produced even when 0.25 per cent of sulphur or phosphorus is present, though the details of the annealing process have to be modified somewhat to suit the kind of iron employed. The problem is how to introduce an iron of a somewhat different composition without disorganizing the work of the smaller manufacturers who depend largely upon old-established methods of working. No doubt in time the larger firms will be forced in this, as in other manufactures, to adopt scientific methods, including chemical analysis and accurate temperature measurement. If this should be the result of the present difficulties the whole industry will benefit permanently. It is generally rcognized that the trade is an important one; that it is capable of very considerable exension; and that it is upon the adoption of scientific methods that such extension (or extinction) will ultimately depend.

Cartridge Brass.—At the annual meeting of the Society of Chemical Industry in Birmingham, England, Dr. H. W. BROWNSDON read a paper on cartridge brass. He said the term includes pure copper-zinc alloys containing 65 to 75 per cent of copper. Such alloys are specially adapted for the manufacture of cartridge cases where the properties of malleability, ductility, and strength require to be combined in such a manner as to facilitate working, and at the same time to produce a finished product which will withstand the shock of firing in rifle or gun.

In order to meet these conditions, the raw materials used, viz., copper and spelter, must be of the highest quality and purity. The copper should be equal to electrolytically refined, and practically free from lead, iron, bismuth, arsenic, antimony, etc., and should on analysis show 99.93 to 99.95 per cent copper. It is desirable to melt down cathode copper into ingots before use in the manufacture of cartridge brass. The spelter should analyze 99.9 to 99.95 per cent of zinc and be as free as possible from lead, iron, arsenic, etc. The two metals, together with a proportion of clean heavy scrap, are melted in crucibles, the molten metals thoroughly mixed and then poured into dressed cast iron ingot molds. A good cartridge brass should not show on analysis more than Fe 0.045 per cent, Pb 0.025 per cent, with traces of other constituents. The cast metal is by subsequent rolling and intermediate annealing reduced to a definite thickness, in which form it is termed finished strip.

The changes in physical properties that the metal un-

dergoes in passing from the ingot to the finished strip are shown by the following figures:

	Yield Point	Tensile Strength	Elongation	Hardness, Brinell
	Tons	Tons	Per Cent	
Ingot (chill cast)	6	16	60—70	60
Strip, hard rolled	Over 20	30—40	10—15	150—200
Finishing strip, annealed at 650 deg. C.	6	20—23	65—75	60

The annealing operations in the manufacture of cartridge brass are carried out at temperatures in the neighborhood of 650 deg. C. It is not uncommon practice to work at a higher temperature than this, say, 680 deg. to 700 deg. C. when annealing the metal in the thicker and heavier stages. By so doing, the time required for annealing is reduced. With thinner metal and products which more rapidly attain to the furnace temperature the 650 deg. C. temperature is more closely observed, the time required being determined by the form of the product to be annealed and by the type of furnace used for the annealing. In muffle furnaces worked intermittently, the time may be three-quarters hour, while in rotary worm-fed gas muffles, suitable for small articles, the time may not exceed five minutes.

Apart from the enormously increased demand during the past three years, there has been no development of interest. Output has largely dominated other considerations.

Firms already engaged in the manufacture before the war have increased their plant and developed the manufacture on pre-war lines. The conditions requiring close attention are:

(1) The chemical composition of the alloy.

(2) The casting of the molten alloy.

(3) The work to which the alloy is submitted during the mechanical operations.

(4) The annealing of the alloys between the mechanical operations.

What may be recognized as the theoretically best method may in practice prove too slow.

It has been difficult during the past years of intensive manufacture to pay the necessary attention to the economical side of the manufacture. From raw material to finished product in the case of cartridge brasses, the percentage loss of material through volatilization, oxidation and pickling amounts to several per cent. Some of this is recoverable and during the annealing process to some extent preventable. The chief improvement to be looked for in this direction is annealing in a non-oxidizing atmosphere. There is nothing new in the idea of preventing oxidation losses during annealing, but, as in numerous other matters, the war has impressed upon us the shortcomings of many pre-war methods.

With the withdrawal of sulphuric acid from use for pickling purposes, and its substitution by nitre cake solutions, the value of clean annealing as against dirty annealing has become much more emphasized, and in the future the bright annealing of all copper alloys should be aimed at.

The manufacturer finds no difficulty in obtaining metal of the purity demanded. In the details of working, the metallurgist knows exactly what he wants both as regards annealing temperatures and work that can be put on the metal. His difficulty is in securing that uniformity of treatment which ensures complete success.

Pyrometry is an essential aid, but its application to this class of work in bulk is still open to considerable improvement. The testing of the hardness of the products during manufacture and when completed is a matter of importance, and the method to be employed is best determined by the nature of the product to be examined. Both the scleroscope and the Brinell instrument are of value, and it is a matter of detail as to which is the more suitable. The fundamental conditions involved in the manufacture are the alternating production of strains by work and their release by annealing. The final product is commonly left in a more or less strained condition. As a means of determining the position and nature of the strains, the weakening of the metal by immersion in mercuric chloride solution, which allows the strains to develop visible cracks, is most valuable.

The success of the industry, therefore, lies in carrying out the manufacture under uniform conditions, which conditions should be governed by:

(1) Analytical control of the metals going into the pot.

(2) Analysis of the cast ingot.

(3) Correct distribution of mechanical work at the various stages of manufacture.

(4) Correct annealing checked by pyrometer, microscope and hardness tests.

Finally, a complete examination, both chemical, metallurgical and physical, of the finished product should be systematically made.

Mr. Alex. E. Tucker said that the heat at which the strips were cast was most important. Were they cast as hot as possible? Then, again, in regard to the manufacture of fine tube the author was emphatic on the point that he received virgin metals of a high grade, but he (the speaker) had often found that copper banding used on cartridges contained a quantity of arsenic. He agreed as to the value of the mercuric chloride test.

Dr. Brownsdon in replying to Mr. Tucker said they worked at the lowest pressure possible right through. It was not unusual to find traces of arsenic in certain kinds of copper. He had been able to trace trouble in cartridge brass to phosphorus. It arose from the scrap metal, and it tended to cause metal to crack when in a strained condition. In regard to the percentage of antimony the quantity was small, probably 0.06 to 0.07 per cent.

Iron and Steel

Hardening High-Speed Steel Tools.—A method of hardening which has been found most successful and economical is described by J. E. ROGERS in the *American Machinist* for Aug. 16, 1917. After experimenting with the carbonizing treatment, in which it was found difficult to regulate the thickness and uniformity of the skin, the following method was adopted, applicable to large and small tools. First, the tools are preheated to 1600 to 1700 deg. F. (the greater the cross-section of the tool the higher the temperature) in an overfired furnace in which oil is used as fuel and steam as the atomizing agent. This preheating shortens the time of the hardening heat which follows, and assures perfect and uniform assimilation of that heat.

The temperature of the hardening furnace, which is similar to the one used for preheating, depends on

the analysis of the steel, which must be known before any heat treatment is attempted. Steels of lower tungsten content harden at much lower temperature than those which contain higher percentages. Having worked with a great many brands of steel, the author finds that temperatures can be included within the limits of 1950 to 2300 deg. F. The correct temperature is essential, and the use of accurate thermo-couples is advised. The length of time of the hardening heat depends on the size of the tool, but should not be prolonged much beyond the time when the determined temperature is reached. Soaking at the hardening temperature may be necessary for the larger pieces, but should never be practiced on smaller, finer tools. The quenching medium is oil, of such character that prolonged use will not cause it to thicken. Tempering should be done at the maximum temperature, from 600 or 700 to 1000 deg. F.

The method can be carried out in any muffle furnace, using the front for preheating and the back for the hardening heat. Loss by this process has been negligible, and the results are the best obtained by any method.

Economizing high-speed steel by welding short tips of the material to shanks of machine or carbon steel has become a practice in many shops, due to the high cost of the high-speed steel. *American Machinist* for Aug. 16, 1917, describes two methods adopted for this purpose. In one case the electric butt welder is used, requiring a current of from 4 to 10 volts and 400 to 500 amperes. For lathe tools the tip of high-speed steel is from 1¼ to 3 in. long. A piece of tin is spot-welded over the joint of the two steel sections to hold them in alignment. The tool is then held in the jaws of the butt welder and the two pieces united. The time required is about ½ minute. For reamers, the tip of high-speed steel is about 2 in. long. For the annealing operations that follow the dressing of the joint the tools are put into an oven at 1600 deg F. for about 6 hours. They are then placed in lime to cool for from 7 to 10 hours. This operation is followed by the hardening process, in which the tools are heated to approximately 2200 deg. F., and quenched in kerosene or fish oil.

Oxy-acetylene welding also is practiced for the same purpose, the high-speed steel tips being clamped in a jig with the machine-steel shank. When the flame of the torch is applied to the joint to be welded the metals expand before the jig becomes heated, and are thus forced together. When the weld is completed the tool is removed from the jig and placed in powdered lime or bar sand to prevent chilling and the formation of hard, brittle spots in the weld.

Gold and Tungsten

Investigation of a Gold and Tungsten Ore in Idaho.—The recent demand for tungsten, and the high prices paid for the metal, led to the reopening of some mines in the Murray district, Idaho, which were reported to contain a gold-tungsten ore. Anticipating an interesting metallurgical study, R. R. GOODRICH and N. E. HOLDEN of the University of Idaho, investigated the mines and made experiments on the ore. While no gold-tungsten ore was discovered, a condition was disclosed which forms the subject of a paper by the investigators in the August *Bulletin* of the A. I. M. E., of which the following is a summary:

> "1. In the Golden Chest vein, the tungsten mineral, scheelite, occurs in rich segregations, in a more or less disturbed or distorted portion of the vein known as the tungsten zone, barren of gold and pyrite-free.
>
> "2. Since the tungsten mineral in the vein occurs in these rich segregations, a considerable portion of the ore is sacked in the stope and sent out to a cleaning floor, where it is brought up to a shipping grade by hand-picking.
>
> "3. In breaking down the ore in the mine, some fine tungsten mineral becomes mixed with waste rock and some pyritic material carrying small gold values. The tungsten mineral is recovered from this material (mill feed) by concentration.
>
> "4. Gravity concentration produces pyritic tungsten concentrates, 53.7 per cent WO_3, with high pyrite content. This is not a shipping grade.
>
> "5. The objections to flotation, as a means of purifying the pyritic tungsten concentrates, are: The purified tungsten concentrates are not sufficiently clean; there is considerable loss of tungsten in the overflow; and fine grinding is required.
>
> "6. The pyritic tungsten concentrates, when treated by roasting for magnetism followed by magnetic separation, yield purified $CaWO_4$ concentrates of shipping grade, WO_3 greater than 60 per cent, and sulphur less than 1 per cent. On all but the two finest sizes, the net recovery, expressed as per cent of WO_3 in the mill feed, is practically 90 per cent or greater, and on the two finest sizes, 76 to 83 per cent.
>
> "7. The investigation of the distribution of gold in the products is interesting only from a technical standpoint and not from a commercial. The profits must be derived from the output of purified $CaWO_4$ concentrates."

Copper, Lead and Zinc

The conservation of mill tailings for future treatment, with present enrichment and segregation as a preliminary step, is the subject matter of a timely paper by F. E. MARCY in the August *Bulletin* of the A. I. M. E. The author reviews the prodigal waste of mill tailings in earlier years, showing how anxious the managers were to get rid of such material by dumping it into streams or lakes where it would be out of the way. Butte, Coeur d'Alene, Flat River, Colorado and Lake Superior districts are cited as typical examples of such waste. At the present time mill tailings are impounded as a matter of necessity forced on many companies by laws against the pollution of streams, and as a consequence millions of tons of such material are available for future treatment. At the same time little discretion has been shown in the segregation of the more valuable from the valueless parts of such tailings, with the result that future treatment is made more difficult. The author enters a plea for segregation at the time the tailings are made, and suggests that this can be done with comparatively little expense and with great benefit for the future. Middlings not now profitable should be stored separately from general tailings, and oxide and carbonate products should be similarly separated from sulphides. Sand should be separated and segregated from slime, and the latter could be again divided into two products of different value. In general, tailings containing probable recoverable metals should not be stored over large areas in horizontal layers, nor should the first tailings of a process, which usually are richer than those made subsequent to improvements, be so placed that they will later be covered by valueless material. The cost of such segregation would be low at the time of initial milling, and should be charged to capital as a deferred asset and not to current operation.

Efficiency of Zinc-Dust Precipitation.—Among the papers offered for the St. Louis meeting of the American Institute of Mining Engineers in October is one on zinc-dust precipitation, by W. J. SHARWOOD, metallurgical chemist for the Homestake Mining Co. After discussing the history and principles of the process and the methods of its application, the author takes up the efficiency of precipitation.

"A precipitating efficiency of 100 per cent. assumes pure zinc, 1 atom of which should precipitate 2 atoms of silver or its equivalent in gold or copper from the double cyanide. At this rate 1 unit weight of zinc should precipitate 6.03 units of gold, 3.30 of silver, or 1.93 of copper, but in actual practice the results are much lower. Applied to commercial dust, the laboratory test usually shows an efficiency value of 30 to 60 per cent. Some extremely fine and pure 'artificial' zinc dusts, prepared by redistillation of spelter, have shown laboratory efficiencies of 75 per cent or more, and pure electrolytic zinc powder is claimed to be equally good. Otherwise the efficiency is generally higher when lead is present to the extent of a percent or two. Distinctly coarse or granular zinc preparations generally show very low results.

"Judged by the actual precious metal precipitated, the working efficiency on a large scale may be a mere fraction of 1 per cent in the case of low-grade gold solutions. A considerable amount of zinc is always wasted in side-reactions, such as the evolution of hydrogen, reducing dissolved oxygen, or precipitating copper and lead. With rich silver solutions the efficiency may approach 50 per cent, especially if no attempt is made to recover the last traces of silver.

"A practical example of mixed precipitation may be taken from the records of the Drumlummon tailing plant, covering three seasons, or twenty-four months of treatment of sandy tailing by leaching, the silver being largely in excess of the gold.

Sand treated	290,000 tons	
Solution precipitated	390,000 tons	
	Lb. Av.	
Precipitate obtained	104,000	
Zinc dust used	113,600	
Metallic zinc dust	102,240	
Zinc remaining in precipitate	40,300 = 39.4%	
Zinc dissolved	61,940 = 60.6%	
Gold in precipitate	2,380 = 0.39%	effi'ncy
Silver in precipitate	16,000 = 4.75%	effi'ncy
Copper in precipitate	7,800 = 3.93%	effi'ncy
Total efficiency (Au, Ag, Cu).....	9.07%	effi'ncy

"Percentage efficiency is calculated by dividing the weight in pounds by the electrochemical equivalent (Zn 32.7, Au 197.2, Ag 107.88, Cu 63.5, and Pb 103.6, under these conditions) dividing the quotient by the number of equivalents of zinc used, and multiplying by 100. The metallic zinc in dust has been taken throughout at the approximate figure of 90 per cent.

"Another instance may be taken from the published results of a month's run (May, 1911) of Sand Plant No. 1 of the Homestake Mining Co., in which the silver is about 1 per cent of the gold value. Some lead was added to the solution as nitrate and recovered in the precipitate.

"The efficiency for gold was 1.18 per cent, for silver, 0.73 per cent, and for copper 0.19 per cent, in the 'weak solution,' making a total efficiency of 2.1 per cent. Similarly the efficiency (Au, Ag, Cu) in the 'low solution' was only 0.71 per cent. At the same time about 1 per cent of the zinc was consumed in precipitating lead."

That such low efficiencies are tolerated in gold extraction is explained by the fact that when "low solution" is going to be thrown away it is obviously worth while to extract the last 2c. worth of gold recoverable, if this can be done at the expense of 1c. for zinc, making a fair allowance for refining cost. With zinc at 14.5c. per pound, 1 oz. Troy costs 1c. If this ounce is used to precipitate 0.001 oz. of gold (2c.) from a ton of waste solution the practice is defensible.

Salt in the Metallurgy of Lead.—A contribution on this subject from the Salt Lake station of the Bureau of Mines is published in the August *Bulletin* of the A. I. M. E. by Messrs. O. C. RALSTON, C. E. WILLIAMS, M. J. UDY and G. J. HOLT. The use of salt as a metallurgical reagent was suggested by the existence of Great Salt Lake and by the past work in chloridizing ores with salt. The experimental work covers a period of three years, during which the following classes of ores were studied: Oxidized ores containing lead, or lead and silver or gold, or lead and zinc with or without silver; sulphide ores of pyrite containing some lead, or complex zinc-lead-iron sulphides, or complex sulphides containing also precious metals. The summary follows:

"1. For the treatment of oxidized ores of lead two methods are available. One involves the leaching of the lead with a saturated salt solution acidified with sulphuric acid, followed by either electrolytic precipitation of metallic lead, or lime precipitation of the basic lead hydroxide with the concomitant regeneration of the salt solution. The other method involves mixing salt with the ore and treatment in a blast roaster, or a reverberatory furnace, at a temperature of 800 deg. C., or more. At these temperatures lead-chloride fumes are formed which can be caught in a Cottrell precipitator, and later reduced to the metallic form by treatment with lime and carbon in either a melting pot or a small reverberatory furnace, with the formation of calcium-chloride slag which can be used as a substitute for sodium chloride in the volatilization step of the process, and means the recovery of from 50 to 75 per cent of the chlorine.

"2. For oxidized lead ores containing precious metals or copper, the leaching process can be used after a chloridizing roast at slightly over 600 deg. C. The volatization process can be used provided temperatures of over 900 deg. C., are used, the ore does not tend to form a slag, and the percentage of sulphur in the ore is low. The zinc in most ores is only slightly affected by this latter process.

"3. Lead can be recovered from practically any sulphide ore by the volatization method, but precious metals and copper cannot be extracted. Precious metals and copper are leached after a chloridizing roast, although the roast is more difficult of accomplishment than is the case with oxidized ores.

"4. The volatilization process promises the solution of the vexing oxidized siliceous lead ores problem so common in the Western arid regions and has the further advantage of requiring very little water for the process. The chloridizing roasting and leaching method promises close competition to treatment of low-grade sulphide ores containing precious metals by gravity and flotation concentration followed by smelting, because of the use of only a few simple operations, the production of finished metal, and of the higher total extractions usually possible. Neither of the salt processes seems to offer a fundamental solution of the 'complex sulphide' problem.

"5. Installations of the volatization method for oxidized ores and of the roasting and leaching method for one sulphide ore are contemplated. The exact data on the ores and processes in these plants will probably be available at some future date."

Petroleum Shales

The commercial possibilities of petroleum shales, particularly those in the Green River formation of northwestern Colorado, are discussed in the *Oil and Gas News* by FREDERICK G. WIRTHMAN. Compared with Scottish shales, which yield a maximum of about 18 per cent oil and 2 per cent ammonium sulphate, the Colorado shales will yield up to 42 per cent oil and 6 per cent ammonium sulphate. According to estimates by the U. S. Geological Survey, the Colorado shales can be made to yield 20,000,000,000 barrels of oil. From the author's experience he would expect a commercial plant to yield the following for each ton of shale treated: 2 lb. of benzole, ½ lb. of cresol, ¼ lb. cresol, ¼ lb. phenol, 5 gal. gasoline, 25 gal. of burning oil, 10 lb. of wax and 100 lb. of ammonium sulphate.

Recent Metallurgical and Chemical Patents

Iron and Steel

Carbohydrates as Deoxidizing Agents.—The deoxidation of iron and steel baths by the addition of carbohydrates is patented by ADOLF KLINKENBERG, of Dortmund, Germany. Claim is made for complete deoxidation, with only traces of carbon entering the bath, and a special advantage is found in the production of very soft iron. The purer the carbohydrate the better the results obtained. Sugar, starch and cellulose are used with best effect, though wood and herbaceous plants such as leather have been used with success. When sugar or starch are used, 2.5 kg. are sufficient to completely deoxidize 1000 kg. of steel. With wood shavings 4 to 5 kg. are necessary. The addition is made preferably by introducing packages of the deoxidizer into the ingot mold when the molten metal is poured therein. Desulphurization also is accomplished, reducing the sulphur content of the metal to 0.02 per cent. (1,238,409, Aug. 28, 1917.)

Gold and Silver

Electrolysis of Cyanide Solutions.—Further investigation in the recovery of gold from cyanide solutions by electrolysis is indicated in a patent granted to U. C. TAINTON and M. F. L. A. AYMARD, of Johannesburg, Transvaal, South Africa. The invention comprehends passing solution under pressure through porous electrodes arranged in an apparatus similar to a filter press, anodes and cathodes alternating with distance frames. The object is to bring the solution into intimate contact with the material of the electrodes, thereby overcoming a defect in former processes. The inventors claim to be able to precipitate 99 per cent of the gold contained in a solution of 3 dwt. per ton in a single passage of the solution through the electrode in a period of less than 5 seconds. Electrodes are in the form of filter frames, the anode being composed of sheets of peroxidized lead covered with filter cloth, and the cathode of filter cloth supported on each side by wire gauze or perforated metal plate. In operation this cathode is to be covered with comminuted conducting material, such as finely divided graphite, which is deposited out of a liquid carrying the same in suspension. When the apparatus is thus prepared for use, a gold-bearing solution is passed through it, and gold is deposited on the graphite of the cathode. (1,231,967, July 3, 1917.)

Copper and Zinc

Electrolytic Precipitation of Copper.—The use of a semi-soluble (iron or steel) anode in the electrolysis of copper solutions is patented by GEORGE C. WESTBY, of Ludwig, Nevada. The object of the invention is to improve processes using insoluble anodes, and thereby overcome objections to such processes by increasing the current and energy efficiency of the operation. It has been established that if the copper solution carries 6 per cent of iron as ferrous sulphate at 60 deg. Fahr. rapid corrosion of the iron anode is prevented. In practice also, a film of carbon and silicious matter remains on the iron anode and further interferes with rapid decomposition. The inventor prepares his solution of copper by bringing roasted or oxidized ores into contact with hot sulphurous fumes containing both sulphur dioxide and trioxide from the decomposition of sulphides and sulphates in a roasting furnace. This solution, charged with SO_2 showing an equivalent acidity of about 1.5 per cent to 2 per cent sulphuric acid, and containing ferrous material, is caused to flow through a flume in which electrodes are placed paralleling the flume. The application of the electric current deposits copper and decomposes a portion of the anode, thereby adding to the ferrous material in solution, and exerting a strong reducing action on such ferric sulphate as might form. Either or both electrodes may be rotated in order that higher current density can be employed and in order to assist in the removal of polarizing gases. (1,231,829, July 3, 1917.)

Purification of Electrolyte.—In a patent granted to FREDERICK J. POPE and ALBERT W. HAHN, of Douglas, Ariz., the inventors disclose their proposed method of keeping the iron and other impurities in the electrolyte at a point consistent with economy in the electrolytic process of depositing copper from its solutions. A portion of the solution coming from the ore is withdrawn from the circuit, the amount depending on the quantity of iron to be removed. Free acid in this solution is neutralized by treating it cold with residues from a previous agitating operation, such residues still containing some copper oxide or sulphate. The neutral solution is then suitably heated and treated with finely ground material containing copper oxide in sufficient quantity to precipitate the iron, and agitation is continued for from two to five hours. Solution and residues are then separated, and the latter used for neutralizing a fresh batch of solution removed from the circuit. The solution thus freed from impurities and enriched in copper is sent to a separate series of cells where copper is recovered and sulphuric acid regenerated. (1,232,080, July 3, 1917.)

Leaching With Chloride Solution.—A hydrometallurgical process for copper, particularly applicable to ores contain calcium carbonate, is patented by WALTER A. SCHMIDT, of Los Angeles, Cal., and by him assigned to the Western Precipitation Company. An active leaching solution is prepared by electrolyzing salt and conducting the chlorine into a leaching solution from which copper has been precipitated. This leaching solution consists of calcium chloride in water, say 5 per cent to 10 per cent strength, and from 0.1 per cent to 0.5 per cent iron as ferrous chloride. The latter is converted into ferric chloride by the chlorine, and again reduced to ferrous chloride when copper is dissolved from its ores. There is sufficient sodium chloride in the solution to carry the cuprous chloride dissolved. When the pregnant solution is precipitated on iron, ferrous chloride again enters solution and is regenerated to the ferric condition by chlorine. Any oxide or hydroxide of iron which is formed in the process is also dissolved to chloride, with the production of hypochlorus acid which is a good solvent for copper. (1,237,220-1, Aug. 14, 1917.)

Electrolytic Deposition of Zinc.—Apparatus for the production of electrolytic zinc in satisfactory physical condition is patented by MARCEL PERREUR-LLOYD, of of Boulogne-sur-Seine, France. It comprises a vessel in which are disposed rotating cathodes in the form of long cylinders, and anodes in the form of perforated lead troughs which almost completely surround the

cathodes, being open at the top. The open space at the top of the anodes permits the removal of cathodes when metal has been deposited to sufficient thickness, and also permits of the application of apparatus designed to remove hydrogen bubbles from the surface of the cathode and render the surface of the metal smooth and even. This latter device consists of fingers mounted on a reciprocating rod above the cathode, each finger carrying a pad of parchmented skin made insoluble by treatment in aldehyde or acetone. (1,235,723-4, Aug. 7, 1917.)

Zinc Retort Furnaces.—Inventions designed to improve retort furnaces for the reduction of zinc oxide to zinc are patented by EDWARD FINK, of Milwaukee, Wis. Figs. 1 and 2 indicate respectively vertical and horizontal sectional views of the apparatus. It comprises a furnace structure 1 and combustion chamber

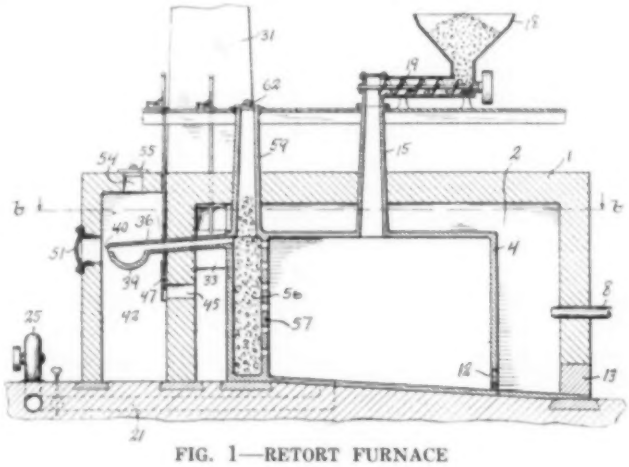


FIG. 1—RETORT FURNACE

2, enclosing retorts, 3, 4, 5 and 6. These latter are long, high and narrow, say 16 ft. long, 8 ft. high and 8 in. wide. They are charged through feed pipes 14 to 17, to which are connected hoppers and conveying mechanisms as shown. Doors 12 and 13 provide means for removing the smelted charge. In front of each retort is a reduction chamber 59, filled with coke to act as a screen to prevent fine dust entering the condenser 36, and to reduce any zinc oxide which may be volatilized before being reduced with the coal or coke that forms a part of the charge.

In another type of furnace the retorts are cylindrical and are vertically disposed in the furnace chamber.

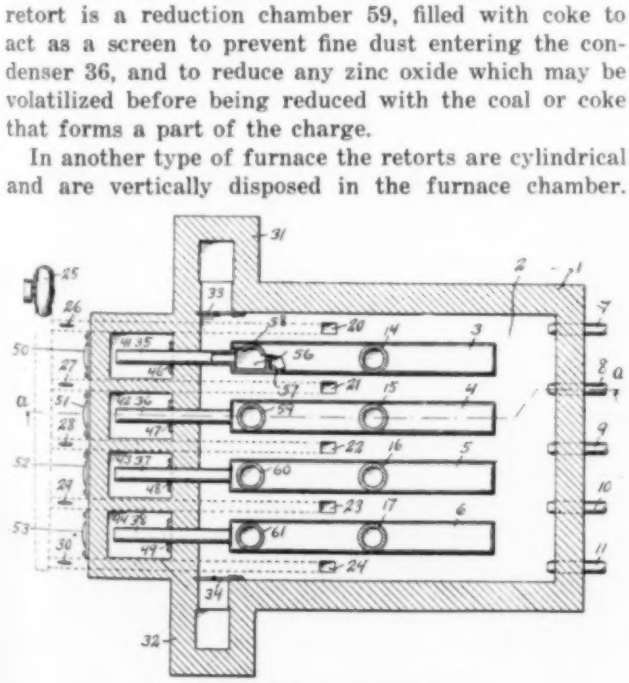


FIG. 2—RETORT FURNACE

Means are provided for charging at the top and removing the spent material at the bottom of each retort. (1,213,346-7, Jan. 23, 1917.)

Condensation of Zinc from Electric Furnace.—A method of handling the zinc dust, or *poussière*, produced in condensing zinc vapors, is patented by EDWARD S. BERGLUND, of Trollhättan, Sweden. In zinc condensation a part of the metal is not recovered as liquid but as powder due to the dilution of the vapors and the difficulty of maintaining in certain parts of the condenser the particular temperature necessary for the condensation of differently diluted zinc vapors. The inventor, therefore, constructs a furnace with two condensers, in the first of which the temperature is adjusted in such a manner that mainly liquid zinc will be condensed. The second condenser receives the gases from the first, cooling them to such an extent that practically all zinc contained therein is condensed as powder. In this way the liquid and powder zinc are separated. In order to prevent the exposure of the zinc powder to the air, where it would be quickly oxidized, the second condenser is provided with a screw conveyor operating in such a manner that the condensed powder is returned to the furnace for further distillation. (1,236,395, Aug. 14, 1917.)

Other Metals

Aluminous Abrasive.—An abrasive for which superior hardness, density, and toughness is claimed is patented by HERBERT T. KALMUS, and assigned to the Exolon Company, of Cambridge, Mass. The invention resides in provision for cooling the fused charge of an electric furnace, so as to permit loss of heat at such a rate as to produce a material that is hard, tough, fine-grained and dense. The preferred method of carrying out the process consists in fusing basic aluminium sulphite in an arc-type electric furnace, and in tapping off the fused alumina in a thin stream into a mold where it can cool rapidly. The fused material can be poured in successive layers in the same mold after each layer has solidified. The product is homogeneous and substantially free from reduction products. (1,226,892, May 22, 1917.)

Recovery of Aluminium and Silicon from Clay.—A metallurgical process and apparatus for this purpose are described in a patent issued to VICTOR M. WEAVER, of Harrisburg, Pa. The clay is treated with chlorine gas at a temperature between 900 deg. and 1200 deg. C., with the resulting formation of aluminium chloride and silicon tetrachloride. These products are condensed at appropriate temperatures, and the liquid aluminium chloride is kept at a temperature of about 200 deg. C. and under a pressure of about 2½ atmospheres. It is subsequently fed to an electrolyzing vat containing fused sodium chloride, and the consequent electrolysis produces metallic aluminium and chlorine. The silicon tetrachloride is fed into a vat containing molten aluminium, where by reason of the greater affinity of chlorine for aluminium than for silicon, the latter is reduced with the formation of aluminium chloride. This is then reduced in the electrolyzing vat as first described. (1,238,604, Aug. 28, 1917.)

Production of Titanic Oxide.—A method of obtaining the oxide of titanium, essentially pure, from such

substances as titaniferous iron ore, ilmenite, rutile, etc., is disclosed in letters patent granted to LOUIS E. BARTON, of Niagara Falls, N. Y., and by him assigned to the Titanium Alloy Manufacturing Company of Niagara Falls. The process consists in dissolving the titaniferous material in sulphuric acid and using this solution as the catholyte in a diaphragm cell, the anolyte of which is sulphuric acid. Lead electrodes are employed. The voltage used is from 5 to 10 volts and the current density about 30 amp. per square foot. The result of the electrolysis is the production of a hydrated compound of titanium which, when calcined at 750 deg. C., is converted into substantially pure titanium oxide. (1,235,638, Aug. 7, 1917.)

Recent Developments in Blast Furnace Blowing Equipment

By E. M. Griffiths

After the general adoption of the steam turbine in large central power stations, the erroneous impression gained ground that the replacing of the reciprocating blowing engine by the turbo blower could only be a question of a comparatively short time. This expectation of the uninitiated was not realized and it is doubtful if it will ever be realized.

The same laws of nature which give the steam turbine advantages over the steam engine are obstacles in the case of the turbo blower. Firstly, the steam turbine excels the steam engine only in the region below atmosphere, and in the compression of air for blast-furnace use this region is absent because, naturally, the compression must start with atmospheric pressure. Secondly, the losses in the earlier or high pressure stages of steam turbine are converted into heat which can be utilized in the latter stages, while in the turbo blower the losses in the early or low pressure stages mean additional work to be done in the latter stages. Thirdly, the steam turbine utilizes the highly efficient process of converting pressure into velocity, whereas, the turbo blower tries to utilize the very inefficient process of converting velocity into pressure. Fourthly, the central power station utilizing large turbo generators makes power for the sake of selling it. High steam pressure, superheat and vacua, which are impracticable around a blast furnace, can be introduced in the central station. Larger and larger units can also be installed, whereas the size of the turbo blower is limited by the size of the blast furnace.

While for these very reasons engineers with knowledge of the underlying principles always had their doubts concerning general adoption of the turbo blower, another rather unexpected reason has considerably delayed and hindered its introduction. The reason in question is incorrect governing of the blower and consequent dusting of the furnace. The turbo blower is a machine supposedly free from pulsations, and great advantages were expected from a steady stream of air going to the furnace. But practice has shown that, quite on the contrary, the vast majority of turbo blowers vary in volume delivery a much greater amount than reciprocating blowing engines do. The amount of ore lost by dusting due to this fluctuation of air supply is so great that most blast furnace managers are, at the present time, afraid to install turbo blowers.

In blowing engines the course of development likewise has been following rather unexpected lines. By comparison of the number of new furnaces built with the number of new blowing engines and new turbo blowers installed, it is found that a comparatively small amount of new blowing equipment has been added. This surprising result is explained by the fact that a very large number of existing blowing engines have been rebuilt in such a way as to have a larger capacity and to serve a greater number of furnaces than heretofore. The possibility of increasing the capacity of existing blowing engines is largely due to the increase in piston speeds made possible by the introduction of plate valves, which have been mentioned before in our columns.

The so-called rebuilding of blowing engines is, in some cases, limited to the simple replacing of the existing valves by automatic plate valves. In other instances it means more than that, namely, the removing of old cylinder heads and replacing them by heads containing plate valves. In the most extreme cases it means the removal of the whole air end, including the air cylinder.

An illustration of the methods employed in replacing an old type of valves by plate valves is shown below in Fig. 1. Here are seen plate valves arranged in cages, which take the place of large poppet valves

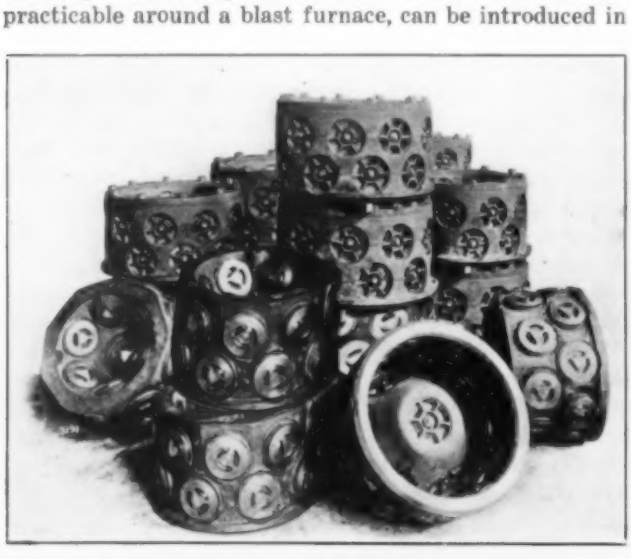


FIG. 1—PLATE VALVES ARRANGED IN CAGES

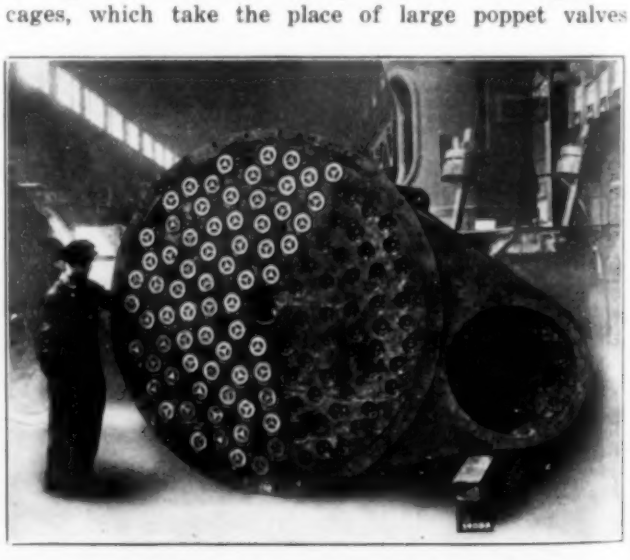


FIG. 2—METHOD OF INSTALLING VALVES IN HEAD

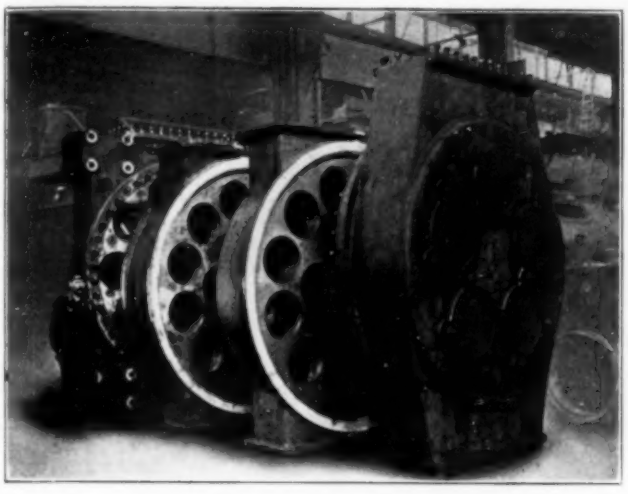


FIG. 3—REPLACING OLD AIR HEADS WITH NEW ONES

originally operating in the head. The cages are dished in order to reduce clearance to a very small amount. In many cases the clearance volume is smaller than it was with the original valves, while in other cases it is increased slightly, depending upon the type of valves being replaced by the cages. But even in this latter case the advantages gained by the instantaneous opening of the valves and the larger area secured are so overwhelming that the slight increase in clearance volume fades into insignificance.

The arrangement of the valves in cages offers several advantages. The removal of one cover plate exposes all outlet valves of the cage to inspection on the delivery side. The inlet cages are made in two parts so that the removal of one cover and the top of a cage exposes all the valves of that cage to inspection. In the extremely rare case of breakage of a valve, the whole cage can be easily removed and replaced by a spare one.

Fig. 2 illustrates the method of installing valves in place of existing valves in the head. This latter method as a rule gives some increase in valve area, but not enough to warrant increasing the speed of the engine materially. This method is to be recommended particularly in the case of old blowing engines equipped with leather valves. The advantage is twofold: first, the plate valves are always tight and in consequence deliver more air, whereas leather valves soon begin to leak, due to warping or charring of the leather; second, higher pressure can be blown.

The second method, namely, that of replacing old air heads with new ones, is very widely practiced at the present time. Fig. 3 (2133) shows the appearance of such air heads. The third and last method, namely, that of replacing the old air end has been necessary only very occasionally.

Mention has already been made of the fact that plate valves allow higher piston speeds. This feature is beneficial in several ways. At present, due to the poor grade of coke available, many furnaces are troubled by the necessity of more air than was used in the past when better coke was on hand. Increasing the supply of air has pulled several furnaces out of a bad predicament. More air means not only more pig iron, but in addition more furnace gas, more steam, and steady, profitable operation.

The installation of plate valves and the resulting possible increase in speed of the blowing engines has enabled a number of plants to erect another furnace without installing additional blowing units. The heretofore customary practice of blowing a furnace with three or sometimes four tubs has given way to the present possibility of blowing a furnace with two tubs only; and, in fact, a great many furnaces in this country are being blown to-day, using only two 84-in. diameter blowing tubs equipped with automatic plate valves. From this it can be seen that the blowing capacity of existing plants can be increased 50 to 100 per cent by equipping the present engines with automatic plate valves.

Mesta Machine Co.,
Pittsburgh, Pa.

Chemical Industries of Austria-Hungary

The chemical industry in Austria-Hungary has remained in a somewhat backward condition, at all events as compared with that of Germany, owing to various causes, such as lack of navigable rivers and canals, high railway rates with consequent high prices for coal and other raw material, antiquated company laws, absence of an enterprising and industrial spirit, and a comparatively limited domestic market. In the economic life of the country the chemical industry plays only an insignificant part, and the number of chemical undertakings was small, and these, indeed, were only of moderate size compared with those in Germany. On the outbreak of war this state of things was keenly realized. The absence of certain raw materials, saltpetre, for instance, necessitated the search for a substitute. The very limited number of chemical works involved the extension of existing ones and the erection of new factories. The manufacture of nitric acid and nitrate of lime from the air was established on a scale undreamed of in peace times; the production of sulphuric acid was enormously increased; factories were also erected for the manufacture of benzole, toluol, glycerine, acetone and for the production of sulphur, chlorine, etc. The mineral wealth of the country was exploited to a much greater extent than before; the sulphuric-acid industry was rendered largely independent of foreign pyrites, and lead and copper and other metals were obtained. The Galician petroleum wells supplied the whole of the Central Powers with oil for light, power and lubrication.

The Austrian chemical industry has, therefore, according to the *Chemical Trades Journal & Chemical Engineer* (information from *Neue Freie Presse*), undergone a tremendous revival and expansion, and it will endeavor to maintain its position after the war. The home industry, it is said, will supply the home demand for chemicals to a much greater extent than heretofore, at first with tariff protection if necessary. The war has shown the supreme importance of the chemical industry to the safety of the State; and its importance to the country's welfare in normal peace times is equally clear and indisputable.

Book Review

Chemical Patents and Allied Patent Problems, by Edward Thomas (John Byrne & Co., Washington, D. C.)

This book presents in very compact form a clear statement of the intention of the patent law of the United States in combination with a reference digest of some

1300 chemical or allied cases illustrative of the interpretation of the law as indicated by judicial opinion.

The digest is in the form of 245 foot notes, to which reference numbers are given in the text. Thus the statements of the text, as one proceeds, are sustained by, or built upon, the citations given in the foot notes. The subject of the text is rendered easily accessible by an extremely comprehensive index having 116 headings, with reference to the pages of the text. Of the 38 pages of the text more than two-thirds of the space is occupied by the 245 foot notes, which are in slightly smaller type than the text.

A complete table of cases gives its references to the serial numbers of the "Notes," which follow consecutively in the text. If, therefore, one wishes to know what is the intention of the patent law, in any particular case, he has but to refer to that portion of the text having the numbers corresponding to those appearing opposite the name of the case given in the alphabetical table of cases. A "Table of Parallel Volumes," from the year 1872 to 1916 inclusive, enables one to locate citations in all of the different authorities.

The book is written from the point of view of an attorney or expert witness instead of that of a Patent Office Examiner, and with that point of view in mind, has specific notes upon the kind of evidence needed, together with notes covering the cases on damages, licenses, etc.

The chemical engineer, and, though less frequently, also the metallurgist, finds it necessary to ascertain the underlying principles of patent law and to familiarize himself with the cases upon which the law of chemical patents is based. For such a purpose this book would render invaluable assistance, and even as a matter of general interest it is fascinating. As a "finding list" for the attorney it would appear indispensable as a time saver.

Personal

Mr. **H. W. Aldrich** has been appointed general superintendent for the Ladysmith Smelting Corporation (British Columbia). Mr. Aldrich had been in the Washoe Plant of the Anaconda Copper Mining Company for ten years, during which time he worked up through the testing department and laboratory to the position of assistant chief chemist. He was in charge of the experimental plants which developed their leaching process, of the completed 2000-ton Leaching Plant, and was later superintendent of the Blast Furnace Department.

Mr. **H. J. Broderson,** instructor in industrial chemistry at the University of Illinois, has accepted a position with the Standard Oil Company at Whiting.

Mr. **Sidney Cadwell** has joined the staff of the Federal Dyestuff and Chemical Co., Kingsport, Tenn. He received his Ph.D. at the University of Chicago during the summer.

Mr. **John Gross** has been appointed metallurgist with the U. S. Bureau of Mines and will be stationed at Fairbanks, Alaska.

Mr. **H. E. Hollister** has resigned as chief engineer of both the Kalbperry Corporation and the Kalbfleisch Corporation to devote his time to the promotion of his newly patented process for the conversion of nitre cake into sulphuric acid and salt cake.

Mr. **E. Jordan** of Toronto, Ont., has been appointed general manager and chief engineer of L'Air Liquid Societé, of Maisonneuve, Que., in succession to E. Royer, who resigned to go into business in Montreal. Mr. Jordan recently came to Canada from France, where the parent company is located. The company is erecting a new manufacturing plant at Halifax, N. S., and is building an addition to its Toronto plant.

Mr. **J. C. Lathrop** has been appointed manager of the recently opened Cincinnati office of the Asbestos Protected Metal Company of Pittsburgh, Pa.

Mr. **W. D. Leonard,** formerly superintendent of the Garfield Smelting Co., has been appointed assistant to the general manager for Colorado of the American Smelting & Refining Co., with headquarters in Denver.

Dr. **Ralph H. McKee,** head of the Research Department of the Tennessee Copper Company, has been appointed to an Associateship in the Department of Chemical Engineering, Columbia University. He will have charge of the work in industrial organic chemistry given by that department. This is the work previously given by Drs. Teeple and Whitaker.

Mr. **Henry A. Oesterle** has been advanced to the post of resident agent for the Illinois Zinc Co. at Joplin, Mo., succeeding the late John Immel. Mr. Oesterle was formerly at the company's headquarters in Peru, Ill.

Mr. **Alfred H. Ramage,** manager of the Ramage mines in Missouri and Oklahoma, has reported for service at the officers' training camp at Fort Niagara, N. Y. He is succeeded in the general management of the Ramage interests by Mr. J. H. Capelli, formerly superintendent of Ramage No. 4 at Carterville, Mo.

Mr. **E. N. C. Rogers** of the Procter & Gamble Co. has taken the September examination of the Cincinnati Board of Education for a special Teacher's Certificate in "English for Foreigners." This is in continuation of the line of "Safety First" campaigning and the teaching of Industrial Arts to which Mr. Rogers devotes his spare time.

Mr. **J. E. Schott** has accepted a position as chemist in the research laboratory of the Federal Dyestuff and Chemical Company, Kingsport, Tenn.

Mr. **A. D. Shankland** has been appointed chief chemist of the Lehigh and Saucon plants of the Bethlehem Steel Co., succeeding F. O. Kichline, recently transferred to Lebanon, Pa. Samuel, Lewis has been appointed chemist at the Saucon laboratory, succeeding A. R. Hartzell, resigned.

Dr. **T. Dale Stewart** of the University of Chicago has gone to Berkeley, Cal., where he has a position as instructor in chemistry at the University of California. He has been in Pittsburgh for several weeks where he has been doing research work for the government.

Mr. **Francis A. Thomson** has resigned as dean of the School of Mines, Pullman, Wash., and will accept a similar position in the University of Idaho.

Mr. **H. N. Thomson** has resigned his position as metallurgist for the United Verde Copper Co. and has entered consulting practice. His address is 918 S. Kingsley Drive, Los Angeles, Cal.

Mr. **Norman L. Warford,** mechanical engineer, in charge of construction for the Powdered Coal En-

gineering & Equipment Company of Chicago, sailed from New York on August 31 to take up his new duties as engineer in charge of the coal pulverizing and copper smelting department of the Societe des Mines de Cuivre de Catemou at Catemou, Chile. Mr. Warford has had many years experience in the use of powdered fuel and was the designer and first operating superintendent of the installation of the Anaconda Copper Mining Company, at Anaconda, Montana, where about one thousand tons of powdered coal per day are used in reverberatory copper smelting furnaces. Mr. Warford was with the Anaconda Copper Mining Company from December 1, 1913, until November 1, 1916, when he went to the Powdered Coal Engineering & Equipment Company. He has been using powdered coal since 1897, principally in cement manufacture, and has had a like experience in designing, erecting and operating cement plants and powdered coal installations for cement, copper smelting and steam raising.

CURRENT MARKET REPORTS

The Iron and Steel Market

The iron and steel market has continued generally stagnant, the monotony being broken occasionally by price declines, relatively minor in their character considering the extent of the readjustment that will probably have to occur before a really active market again presents itself.

In the case of finished steel products the slight declines that have occurred thus far have, in essence, been a reduction in premiums involved on early deliveries, for as a rule the latest advances in the upward movement occurred on early deliveries, buying for really forward delivery having been practically suspended, not later than last April. In the case of pig iron the relatively slight declines that have occurred have been from a completely established market, for the highest prices developed on the rise were being paid for late deliveries, chiefly the fore part of 1918, as consumers were almost entirely covered for the remainder of this year before the last advances occurred.

Basic pig iron, which attained a level of $54, valley, late in June, sold in the past fortnight at $42, with more iron offered at the price than was absorbed. In other grades of valley iron, and in other markets, there was no corresponding pressure of offerings and price declines have been slight. It is obvious that appraised values have decreased but there has been so little trading that the full decrease has not been written into the actual quotable market. The furnaces endeavor to maintain quotations and transactions are confined to small lots for immediate shipment, the price being of minor consequence to the buyer.

The whole market situation, in pig iron, unfinished steel and finished steel, is that buying is confined to pressing requirements and involves very small tonnages. The transactions are not such as to develop real values, as the quantities bought are inconsequential to the buyer and the price paid is unimportant.

THE GOVERNMENT AND PRICES

When this market stagnation developed, late in June and early in July, there was a disposition to maintain that the trade was waiting upon action at Washington in the matter of price fixing, and it became a common saying that the market was "waiting upon action at Washington." If such a view were ever correct, it certainly has not been correct in the past few weeks. It is obvious that there is no conceivable action Washington could take that would bring buyers of iron and steel into the market so as to inaugurate a fresh buying movement.

The Government can fix prices upon the steel it buys, but it seems to be settled now that there will be no general price schedule, fixing flat prices that shall be paid upon all purchases. Rather the practice is to place orders at definite prices, but which are considered tentative while operating costs during the filling of the orders are studied. The Government is indisposed to announce the prices it pays, and as producers feel that the open market would tend to decline to the Government level in case the prices became public they are indisposed to give out the information. Thus this business does not tend to set a pace for the general market.

As to purchases by or for the account of our Allies, there is serious question whether the Government has power to fix prices, and even if it had, the prices would be no more likely to become established as matter of common knowledge than prices paid for the Government's own steel. Thus in this respect there is no action to be taken by Washington that would furnish a lead for the general market.

There remains the matter of the Government fixing prices for the general market, as was done August 21 in the case of coal. The authority is not vested in the executive at present, but this is contemplated in the Pomerene bill now in the Senate. If this bill should be passed and acted upon, both contingencies being quite doubtful, it is quite certain that the market would not immediately proceed to trade at the prescribed prices. The Government cannot force either sellers or buyers to act. Either sellers would refuse to sell, as long as they had any orders to fill, or buyers would refuse to buy as long as they had any material in stock or due them. The last ton of business now under engagement would have to be carried out before there would be any general action.

If the market is allowed to proceed to develop itself according to normal trade practices it would find its level, a level at which buying and selling on a fair scale could go on, at a much sooner date, hence action at Washington is completely eliminated as the chief market factor for the next definite turn in the iron and steel market.

BUSINESS ON BOOKS

The blast furnaces are sold up practically full to the end of the year, and as to 35 to 60 per cent of their prospective output in the first half of the new year. The large steel mills are claimed to be sold fully to the end of the year, with much business under engagement for the new year. The Steel Corporation's unfilled obligations are slightly in excess of 10,000,000 tons, equal to production for 200 working days, if suitably distributed in the different departments and certain to be specified against. At the middle of last year it was believed that fully one-half the mill obligations were in the form of actual shipping orders. At the present time the proportion is much less. The smaller mills

have much smaller obligations, relative to capacity, than the large mills.

The steel market is usually discussed from the viewpoint of the seller, but there are two sides. When the business tide is rising, the feature of the situation is that the mills have a given tonnage already sold. With prices advancing buyers are sure to call for all the tonnage by which the mills have obligated themselves. When the tide is ebbing, the tonnage on books must not be looked upon as so much sold, but rather as so much bought. If a tonnage has been sold it also has been bought, and if the tonnage bought is more than the buyers find they will require, and therefore more than they will specify, the magnitude of the tonnage involved is not an element of strength, but rather the reverse.

PROSPECTS OF CONSUMPTION

A sketch of the situation and prospects as to consumption is as follows. In 1912 and 1913, the two largest years before the war, the domestic consumption, indicated by the total rolled steel production minus all exports direct and indirect, was a trifle less than 21,000,000 gross tons. A similar computation for 1916 shows a trifle under 25,000,000 tons. The present capacity is about 35,000,000 tons, with production at the rate of between 90 and 95 per cent of capacity. Requirements for the future involve: (1) Steel required by the Government; (2) steel required by our Allies; (3) steel required by ordinary domestic consumers. The Government requirements, according to orders thus far placed or in prospect, do not seem to involve more than 10 to 15 per cent of the output. The requirements of the Allies have not been expressed, to any extent, for several months. Heavy shipments have been going forward without a corresponding amount of fresh buying. In order that the combined war requirements should amount to 30 per cent of the total capacity there will have to be much more buying for account of the Allies than has lately been the case. If eventually the buying should prove heavier than formerly it will be time enough then to consider the situation. At 30 per cent for the war requirements of the Government and its Allies, full production of steel would find an outlet only in case the ordinary domestic consumption were as great as in 1916, and this seems unlikely to be the case, when building operations are being suspended very largely and the mass of the people are practicing voluntary or forced economy. From this viewpoint the readjustment in iron and steel prices, which has been proceeding in very modest fashion in recent week, is liable to go to great lengths eventually.

Non-Ferrous Metal Market

Monday, Sept. 24.—The chief features have been the continued rise in silver and the decline in lead, which experienced two sharp breaks.

Copper.—The copper market continues dull with now and then a slight sign of activity. Rumors were still going the rounds in regard to Government price fixing. Prompt electrolytic is quoted at 26.50 to 26.75 with November 26.25 and December, 26.00. These are holder's prices. Prompt lake is held at 27.00 to 27.75.

Tin.—The tin market continues dull, the foreign market declining on Sept. 20 £1 in London to £244 on spot Straits. Spot Straits in New York is held at about 61.25 cents. Banca is 59.50, with Chinese No. 1 at 55.50 for futures. Straits for December-January shipment from the East Indies can be had for 56.50. Arrivals up to Sept. 21 were 1685 tons—a very low figure.

Lead.—The trust reduced the price twice since our last report, first to 9 cents on the 13th and then to 8 cents on the 18th. These cuts bring the price down to the level of the price fixed for lead by the Government. The price of 8.00 cents is also asked by independents and no reduction is quoted on deliveries up to November. The reductions have stimulated buying somewhat.

Spelter.—There is nothing new in the spelter market, except that the Government is buying on competitive bids instead of fixing a price and then allotting contracts. Prompt spelter is quoted at 8.25 E. St. Louis and 8.42½ New York.

OTHER METALS

Antimony, Chinese and Japanese, pound	$0.15¼
Aluminium, No. 1 Virgin, 98-99 per cent, pound	.41–.42
Magnesium, metallic, pound	2.00–2.50
Nickel, electrolytic, pound	.55
Cobalt, pound	2.70
Cadmium, pound	1.50
Quicksilver, flask	115.00
Silver, ounce	1.06½
Platinum, pure, ounce	105.00
Palladium, ounce	115.00

Chemical Market

COAL TAR PRODUCTS.—The general position of these markets has been rather quiet with some items a trifle easier for the fortnight.

Benzol.—Orders are still rather limited but prices are somewhat steadier under the influence of increased buying interest. A few contracts for picric acid have been let, taking some of the surplus stocks of benzol off the market.

Aniline Oil.—The market has not been particularly active and the export business has been limited. Prices are still comparatively low in comparison with the cost of production. The situation has not favored the manufacturer of late.

Paranitraniline.—Business has been quiet, causing a contraction of production. Prices have remained fairly steady. A few important inquiries, however, have been noted lately.

Metanitraniline.—Three of four domestic manufacturers have had very little to offer recently and prices are higher. A new production is offered on contract and the steady demand bids fair to absorb everything offered.

Monochlorbenzol.—Export inquiries have been light. Supplies have been adequate and prices have been about the same as before.

Dinitrochlorbenzol.—The absence of business has brought about lower prices and as competition grows the market weakens.

Toluol.—About 95 per cent of the present production is going into the manufacture of explosives. Dye manufacturers are experiencing difficulty in securing supplies. Prices on short term contracts are firm with an advancing tendency.

Dinitrotoluol.—The one or two new producers are having but little difficulty in selling their product and prices are firmly maintained.

Toluidines.—These products are about as previously noted. An active demand prevails for the para. Prices about unchanged.

Naphthalene.—The spot market is very quiet. Some price shading is in evidence. Large producers have just established their 1918 prices to the drug trade and these are about 2c. higher than this year's contract prices. The contract inquiry is widening.

Phenol.—The market is stronger and prices are on the advance. Considerable spot business of much importance has passed and contracts especially are wanted.

Dinitrophenol.—Prices on this intermediate are lower owing to competition. Several important inquiries, however, have developed of late.

Para-amidophenol.—The production is increasing and prices are somewhat lower on competition. The demand however is quite steady for both the base and the hydrochloride.

HEAVY CHEMICALS.—During the last couple of weeks considerable activity has been in evidence, and this was not alone true of a few speculative items, but was along general lines, and the indications are now that the coming season will be one in which a large volume of business will be regularly in evidence.

Caustic Soda.—Prices have almost steadily advanced although during the last few days a slight reaction has taken place; this, however is expected to be only temporary, as makers are well sold up for nearby delivery and on contract over next year. The speculative element has and is playing an important part, but the fact remains that consuming business has been exceedingly heavy; exports especially to France, Italy and the Orient have broadened a great deal lately. A great deal of interest is attached to next year's business, and there are very few makers who have not sold a large part of their production for this position.

Soda Ash.—Not a little activity has come to this market, and prices are somewhat higher, because of the fact that demand has been heavier induces many buyers to cover on forward positions, and practically all futures now are held at higher prices.

Bleaching Powder.—Nothing of importance has occurred, and sellers are still quoting rather low prices for nearby delivery in domestic drums; the export inquiries are fairly good, and business appears to be increasing somewhat.

Cyanides.—The markets have been fairly steady and the inquiry for the potassium is a bit stronger under light offerings. Demand also for the sodium has improved somewhat, and prices are a few cents higher than a fortnight ago.

Barium Compounds.—There has been considerable activity lately, especially in the carbonate, makers of which have in most cases sold ahead. The demand for the chloride and nitrate appears to be improving somewhat, and sellers are holding now with more firmness than heretofore.

Silicate of Soda.—Supplies of the 60-deg. material are exceedingly scarce, and sellers are not in a position to take any nearby business, and futures are higher in price; occasionally a lot reaches the open market but as a rule this goes immediately into consuming channels at rather high prices; the 40-deg. material is also firm, although not so difficult to obtain as the higher grade.

Bichromate of Soda.—Under heavy speculation, and the efforts of large manufacturers, the prices have advanced considerably, although during the last week or so demand has let up somewhat, and slight reactions were taken; in view of the fact, however, that 1918 contracts are to be placed within the next few months, an effort will be made to maintain values.

Bichromate of Potash.—There is a fairly strong tone to the market, and sellers are holding with a great deal of firmness at the recently increased levels.

Chlorates.—There is a fairly strong tone to the market for both the potash and soda, and prices have been maintained with a great deal of strength.

Copper Sulphate.—Nothing of unusual interest has developed, and sellers continue to quote at prices that have been evidence for some time. There is a steady tone to the market, and export business is fairly active.

Arsenic-White.—There is a good demand for this product, and sellers in some cases have advanced their prices for nearby delivery.

Arsenate of Lead.—Large makers have just announced their prices for nearby delivery and on contract, and the insecticide trade is coming into the market in fairly good volume.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET SEPT 20, 1917

Acetic anhydride	lb.	1.90	—	2.00
Acetone, drums	lb.	.35	—	.36
Acid, acetic, 28 per cent	lb.	.06	—	.06½
Acetic, 56 per cent	lb.	.11	—	.13
Acetic, glacial, 99½ per cent, carboys	lb.	.37	—	.38
Boric, crystals	lb.	.13½	—	.14
Citric, crystals	lb.	.72	—	.72½
Hydrochloric, commercial, 18 deg	lb.	.01⅝	—	.01¾
Hydrochloric, 20 deg	lb.	.01¾	—	.01⅞
Hydrochloric, C.P., conc., 22 deg	lb.	.01⅞	—	.02
Hydrofluoric, 30 per cent, in barrels	lb.	.05	—	.05¼
Lactic, 44 per cent	lb.	.11	—	.12
Lactic, 22 per cent	lb.	.05	—	.05½
Nitric, 36 deg	lb.	.07¼	—	.07⅝
Nitric, 42 deg	lb.	.07⅞	—	.08
Oxalic, crystals	lb.	.46	—	.47
Phosphoric, 85 per cent	lb.	.35	—	.39
Picric	lb.	.70	—	.75
Pyrogallic, resublimed	lb.	3.20	—	3.30
Sulphuric, 60 deg	ton	27.00	—	30.00
Sulphuric, 66 deg	ton	34.00	—	35.00
Sulphuric, oleum (Fuming), tank cars	ton	40.00	—	45.00
Tannic, U. S. P., bulk	lb.	1.35	—	1.40
Tartaric, crystals	lb.	.78½	—	.79
Alcohol, grain, 188 proof	gal.	4.30	—	4.35
Alcohol, wood, 95 per cent	gal.	1.10	—	1.12
Alcohol, denatured, 180 proof	gal.	1.00	—	1.02
Alum, ammonia lump	lb.	.04¼	—	.04½
Alum, chrome ammonium	lb.	.18½	—	.19
Alum, chrome potassium	lb.	.25	—	.27
Alum, chrome sodium	lb.	.12½	—	.13
Alum, potash lump	lb.	.08½	—	.09
Aluminium sulphate, technical	lb.	.02	—	.02½
Aluminium sulphate, iron free	lb.	.03¼	—	.03½
Ammonia aqua, 26 deg. carboys	lb.	.12	—	.13
Ammonium carbonate	lb.	.11¼	—	.12
Ammonium nitrate	lb.	.22	—	.24
Ammonium, sulphate domestic	lb.	.07⅛	—	.07¼
Amyl acetate	gal.	4.50	—	4.60
Arsenic, white	lb.	.16	—	.16½
Arsenic, red	lb.	.60	—	.65
Barium carbonate, 99 per cent	ton	70.00	—	75.00
Barium carbonate 97-98 per cent	ton	65.00	—	
Barium chloride	ton	85.00	—	90.00
Barium sulphate (Blanc Fixe, powder)	lb.	.04	—	.04½
Barium nitrate	lb.	.11½	—	.12
Barium peroxide, basis 70 per cent	lb.	.27	—	.27½
Bleaching powder, 35 per cent chlorine	lb.	.01¾	—	.02⅛
Borax, crystals, sacks	lb.	.08	—	.08½
Brimstone, crude	ton	60.00	—	65.00
Bromine, technical	lb.	.70	—	.80
Calcium, acetate, crude	lb.	.03	—	.03½
Calcium, carbide	lb.	.08½	—	.09
Calcium chloride, 70-75 per cent, fused, lump	ton	36.00	—	38.00
Calcium peroxide	lb.	1.60	—	1.70
Calcium phosphate	lb.	.30	—	.31
Calcium sulphate	lb.			
Carbon bisulphide	lb.	.17	—	.17½
Carbon tetrachloride, drums	lb.	.16½	—	.16¾
Caustic potash, 88-92 per cent	lb.	.85	—	.87
Caustic soda, 76 per cent	lb.	.09⅝	—	.10
Chlorine, liquid	lb.	.15	—	.40
Cobalt oxide	lb.	1.40	—	1.50
Copperas	100 lb.	1.00	—	1.05
Copper carbonate	lb.	.45	—	.47
Copper cyanide	lb.	.75	—	.78
Copper sulphate, 99 per cent, large crystals	lb.	.09¼	—	.09½
Cream of tartar, crystals	lb.	.50	—	.51
Epsom salt, bags	100 lb.	4.15	—	4.25
Formaldehyde, 40 per cent	lb.	.16	—	.16½
Glauber's salt	100 lb.	.80	—	.85
Glycerine, bulk, C. P.	lb.	.65	—	.66
Iodine, resublimed	lb.	3.50	—	3.55
Iron oxide	lb.	.13	—	.15

Lead, acetate, white crystals	lb.	.16	—	.17
Lead arsenate	lb.	.13½	—	.14
Lead nitrate	lb.	.17½	—	.18
Litharge, American	lb.	.10½	—	.12¼
Lithium carbonate	lb.	1.02	—	1.05
Manganese dioxide, U. S. P	lb.	.48	—	.55
Magnesium carbonate, tech	lb.	.16	—	.16½
Nickel salt, single	lb.	.11	—	.11½
Nickel salt, double	lb.	.08	—	.08½
Phosphorus, red	lb.	1.50	—	1.60
Phosphorus, yellow	lb.	2.20	—	2.25
Potassium bichromate	lb.	.44	—	.45
Potassium bromide granular	lb.	1.35	—	1.40
Potassium carbonate calcined, 80-85 per cent	lb.	.70	—	.75
Potassium chlorate, crystals	lb.	.54	—	.55
Potassium cyanide, 98-99 per cent	lb.	2.30	—	2.50
Potassium iodide	lb.	2.00	—	2.92
Potassium muriate 80-85 p.c. basis of 80 p.c	ton	330.00	—	340.00
Potassium nitrate	lb.	.29	—	.30
Potassium permanganate	lb.	4.00	—	4.25
Potassium prussiate, red	lb.	2.90	—	3.00
Potassium prussiate, yellow	lb.	1.20	—	1.25
Potassium sulphate, 90-95 p.c. basis 90 p.c	ton	300.00	—	325.00
Rochelle salts	lb.	.39	—	.39½
Salammoniac, gray gran	lb.	.11	—	.11½
Salammoniac, white gran	lb.	.16	—	.16½
Sal soda	100 lb.	1.20	—	1.25
Salt cake	100 lb.	1.10	—	1.15
Silver cyanide, based on market price of silver	oz.	....	—	....
Silver nitrate	oz.	.64	—	.66
Soda ash, 58 per cent. light, flat	100 lb.	3.50	—	3.60
Soda ash, 58 per cent, dense, flat	100 lb.	3.90	—	4.00
Sodium acetate	lb.	.11	—	.11½
Sodium benzoate	lb.	1.75	—	2.00
Sodium bicarbonate, domestic	100 lb.	2.45	—	2.50
Sodium bicarbonate, English	lb.	....	—	....
Sodium bichromate	lb.	.26	—	.27
Sodium bisulphite, powd	lb.	.04½	—	.05
Sodium chlorate	lb.	.24	—	.25
Sodium cyanide	lb.	.54	—	.55
Sodium fluoride, commercial	lb.	.18	—	.18½
Sodium hyposulphite	lb.	.01¾	—	.02
Sodium nitrate, 95%	100 lb.	5.00	—	5.25
Sodium nitrite	lb.	.45	—	.50
Sodium peroxide	lb.	.75	—	.80
Sodium phosphate (tri.)	lb.	.04¾	—	.05
Sodium prussiate, yellow	lb.	.36½	—	.37
Sodium silicate, liquid—40 deg. Baumé	100 lb.	2.50	—	2.60
Sodium sulphide, 30 per cent crystals	100 lb.	3.00	—	3.10
Sodium sulphide, 60 per cent, fused	100 lb.	4.50	—	4.55
Sodium sulphite	lb.	.04	—	.05½
Strontium nitrate	lb.	.28	—	.30
Sulphur chloride, drums	lb.	.06	—	.06½
Sulphur dioxide, liquid, in cylinders	lb.	.15	—	.40
Sulphur, flowers, sublimed	100 lb.	4.05	—	4.10
Sulphur, roll	100 lb.	3.70	—	3.85
Sulphur, crude	ton	60.00	—	65.00
Tin bichloride, 50 deg	lb.	.19¾	—	.20
Tin oxide	lb.	.64½	—	.65
Zinc carbonate	lb.	.25	—	.27
Zinc chloride	lb.	.16	—	.17
Zinc cyanide	lb.	.50	—	....
Zinc dust 350 mesh	lb.	.17	—	.19
Zinc oxide, American process XX	lb.	.15½	—	.16
Zinc sulphate	lb.	.06	—	06¾

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.50	—	.52
Benzol, 90 per cent	gal.	.50	—	.52
Toluol, pure water white	gal.	1.75	—	1.80
Xylol, pure, water white	gal.	.45	—	.50
Solvent naphtha, water white	gal.	.18	—	.22
Solvent naphtha, crude, heavy	gal.	.13	—	.16
Creosote oil, 25 per cent	gal.	.33	—	.35
Dip oil, 20 per cent	gal.	.29	—	.30
Pitch, various grades	ton	8.00	—	20.00
Carbolic acid, crude, 95-97 per cent	lb.	1.05	—	1.10
Carbolic acid, crude, 50 per cent	lb.	.60	—	.65
Carbolic acid, crude, 25 per cent	lb.	.32	—	.35
Cresol, U. S. P	lb.	.19	—	.20

Intermediates, Etc.

Alpha naphthylamin	lb.	.70	—	.75
Aniline oil	lb.	.26½	—	.27
Aniline salts	lb.	.33	—	.34
Anthracene, 80 per cent	lb.	.10	—	....
Benzaldehyde	lb.	4.00	—	4.50
Benzidine, base	lb.	1.85	—	1.90
Benzidine, sulphate	lb.	1.50	—	1.55
Benzoic acid	lb.	1.75	—	2.00
Benzyl chloride	lb.	1.75	—	2.00
Beta naphthol benzoate	lb.	7.50	—	9.00
Beta naphthol, sublimed	lb.	.85	—	.90
Beta naphthylamin com	lb.	2.50	—	....
Dichlor benzol	lb.	.12	—	.18
Dinitrochlorbenzol	lb.	.42	—	.44
Dimethylaniline	lb.	.57	—	.59
Diphenylamine	lb.	1.00	—	1.10
H-acid	lb.	3.00	—	3.50
Metaphenylenediamine	lb.	1.75	—	1.80
Monochlorbenzol	lb.	.22	—	.23
Naphthalene, flake	lb.	.09	—	.09¼
Naphthionic acid, crude	lb.	1.50	—	1.75
Nitro naphthaline	lb.	.45	—	.50
Nitro toluol	lb.	.50	—	.55
Ortho-amidophenol	lb.	....	—	....
Ortho-toluidine	lb.	.90	—	1.00
Para-amidophenol, base	lb.	4.00	—	5.00
Paranitraniline	lb.	1.05	—	1.10
Paraphenylenediamine	lb.	3.50	—	4.00
Para toluidine	lb.	2.00	—	2.10
Phenol, U. S. P	lb.	.42	—	.43
Resorcin, technical	lb.	8.00	—	9.00
Resorcin, pure	lb.	13.50	—	15.00
Salicylic acid	lb.	1.40	—	1.50
Salol	lb.	1.85	—	2.00
Sulphanilic acid	lb.	.32	—	.35
Tolidin	lb.	3.00	—	....
Toluidine-mixture	lb.	.75	—	.85

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	3.50	—	....
Corning, Ohio	bbl.	2.60	—	....
Somerset, Ky	bbl.	2.40	—	....
Wooster, Ohio	bbl.	2.38	—	....
Indiana	bbl.	1.98	—	....
Illinois	bbl.	2.12	—	....
Oklahoma and Kansas	bbl.	2.00	—	....
Caddo, La., light	bbl.	2.00	—	....
Corsicana, Tex., light	bbl.	2.00	—	....
California	bbl.	.98	—	1.32
Gulf Coast	bbl.	1.00	—	....

Fuel Oil

New York	gal.	.10½	—	....
Pittsburgh	gal.	.07½	—	.10
Oklahoma-Kans	bbl.	.70	—	1.55
Texas	bbl.	1.75	—	....
Los Angeles	bbl.	1.45	—	....
San Francisco	bbl.	1.45	—	....

Gasoline (Wholesale)

New York	gal.	.24	—	....
Boston	gal.	.25	—	....
Pittsburgh	gal.	.25	—	....
Chicago	gal.	.21	—	....
Oklahoma	gal.	.23	—	....
San Francisco	gal.	.20	—	....

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.13½	—	.14
Cylinder, light	gal.	.21	—	.26
Cylinder, dark	gal.	.18	—	.19
Paraffine, high viscosity	gal.	.29½	—	.30
Paraffine, .903 sp. gr	gal.	.21½	—	.22
Paraffine, .865 sp. gr	gal.	.18½	—	.19

Flotation Oils

(Prices at New York)

Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.52	—	....
Pine oil, destructively distilled, sp. gr. 0.920-0.940	gal.	.48	—	.53
Pine-tar oil, sp. gr. 1.025-1.035	gal.	.25½	—	....
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.35	—	....
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	....
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.26	—	....
Pine tar, thin, sp. gr. 1.060-1.080	gal.	.22	—	....
Turpentine, crude, sp. gr. 0.980-1.000	gal.	.40	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.19	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.19	—	....
Wood creosote, ref	gal.	.30½	—	....

Vegetable and Other Oils

China wood oil	lb.	.19½	—	.20
Cottonseed oil, crude	gal.	1.06	—	1.08
Linseed oil, raw, cars	gal.	1.20	—	....
Peanut oil, crude	gal.	1.17	—	1.20
Rosin oil, first run	gal.	.35	—	....
Rosin oil, fourth run	gal.	.66	—	....
Soya bean oil, Manchuria	lb.	.14	—	.14½
Turpentine, spirits	gal.	.44	—	....

Miscellaneous Materials

Barytes, floated, white, foreign	ton	38.00	—	40.00
Barytes, floated, white, domestic	ton	30.00	—	36.00
Beeswax, white, pure	lb.	.65	—	.68
Carnauba wax, flor	lb.	.53	—	....
Casein	lb.	.22	—	.30
Chalk, light, precipitated, English	lb.	.03	—	.06
Feldspar	ton	8.00	—	12.00
Fuller's earth, powdered	100 lb.	1.00	—	1.50
Ozokerite, crude, brown	lb.	.60	—	.70
Ozokerite, American, refined, white	lb.	.75	—	1.00
Red lead, dry, carloads	lb.	.13	—	....
Rosin, 280 lb	bbl.	6.00	—	....
Soapstone	ton	10.00	—	12.50
Talc, American, white	ton	15.00	—	18.00
White lead, dry	lb.	.11½	—	....

Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	Nominal		
Chrome cement, Grecian	net ton	Nominal		
Clay brick 1st quality fireclay	per 1000	50.00	—	55.00
Clay brick, second quality	per 1000	35.00	—	40.00
Magnesite, raw	ton	30.00	—	35.00
Magnesite, calcined	ton	40.00	—	55.00
Magnesite, Grecian, dead burned	net ton	85.00	—	90.00
Magnesia brick, Grecian, 9x4½x2½	net ton	135.00	—	140.00
Silica brick	per 1000	50.00	—	60.00

Ferroalloys

Ferrocarbontitanium, 15-18 per cent, carloads, f.o.b. Niagara Falls, N. Y	ton	160.00	—	....
Ferrochromium, per lb. of Cr	lb.	.30	—	.40
Ferromanganese, domestic, delivered	ton	375.00	—	400.00
Ferromanganese, English	ton	375.00	—	....
Ferromolybdenum, per lb. of Mo	lb.	4.00	—	4.40
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	225.00	—	250.00
Ferrosilicon, 50 per cent, contract	ton	100.00	—	150.00
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2.60	—	2.65
Ferrouranium, f.o.b. works, per lb. of U	lb.	7.00	—	....
Ferrovanadium, f.o.b. works	lb.	3.25	—	3.50

Ores and Semi-finished Products

Chrome ore, 48 per cent minimum, f.o.b. Cal., per unit	ton			.90
Manganese ore, 48 per cent and over, per unit	ton			1.00
Molybdenite, per lb. of MoS_2	lb.			2.20
Tungsten, Scheelite, per unit of WO_3	ton			25.00
Tungsten, Wolframite, per unit of WO_3	ton			24.00
Uranium oxide, 96%	lb.	3.40	—	3.60
Vanadium Pentoxide, 99%	lb.			11.00

INDUSTRIAL

Financial, Construction and Manufacturers' News

New Companies

Allied Drug & Chemical Corp., Wilmington, Del. Capital $1,000,000. To make drugs, chemicals, etc. W. S. Randall, F. A. Armstrong, C. M. Egner, Wilmington, Del.

The Alosta Chemical Co., Los Angeles, Cal. Capital $10,000. W. R. McNair, S. A. Wright and L. Hyde.

The Ambler Chemical Corp., Pearl River, N. Y. Capital, $100,000. To manufacture chemicals and allied products. Incorporators are A. R. Oakley, Pearl River; W. E. Shields, Jr., and Paul E. Britsch, Brooklyn, N. Y.

American International Steel Corp., Portland, Me. Capital $1,000,000.

The Argo Oil Company, Dover, Del. Capital, $10,000. To develop oil lands. Incorporators are G. G. Stiegler, William F. O'Keefe and E. E. Wright, Wilmington.

Atlantic & Pacific Safety Explosives Corp., Wilmington, Del. Capital $500,000. To make, sell and deal in all kinds of powder and explosives, etc. W. F. O'Keefe, G. G. Stiegler, E. E. Wright, Wilmington, Del.

The Automotive Corp., Dover, Del. Capital, $10,000,000. To manufacture engines, motor trucks, etc. Incorporators are Clement M. Enger, Elkton, Md.; M. V. Haywood and C. L. Rimlinger, Wilmington, Del.

The Babcock Scientific Paint & Oil Co., Newark, N. J. Capital, $125,000. To manufacture paints, etc. Incorporators are L. H. Graham, Scarsdale, N. Y.; A. H. Scarborough, New York City, and R. N. Schoemaker, Newark.

Bergman Co., Inc., Brooklyn, N. Y. Capital, $10,000. To deal in chemicals, dyes, paints, varnishes. W. J. Molinari, H. C. Ehrlich, S. Cohen, 31 Liberty Street, Manhattan.

Chonon Bernstein, Inc., New York City. Nominal capital, $5,000. To manufacture chemicals, etc. Incorporators are L. Scott and C. and E. Bernstein, 253 West 112th Street, New York.

C. Berthel & Co., Inc., New York. Capital $10,000. To deal in chemical drugs, Chinese articles. C. H. Berthel, R. Weller, A. Sharp, New York.

C. & C. Leather Co., Newark, N. J. Capital $75,000. To manufacture and deal in leather. Incorporators, B. N. Chanalis, V. O. Compalattaro and M. B. Chanalis, all of Newark.

The Cap Rock Oil & Gas Co., Chicago, Ill. Capital, $200,000. To engage in the production of oil and gas. Incorporators are W. C. Malone, W. O. Daly and J. G. Burns, all of Chicago.

The Carbon Products Co., Dover, Del. Capital, $120,000. To manufacture tar dyes, creosote and kindred products. Incorporators are M. B. F. Hawkins, J. G. Gray and H. M. Kennedy, Wilmington.

Conshohocken Steel & Alloy Corp., Philadelphia, Pa. Capital $250,000. Incorporators are F. R. Hansell, Philadelphia; J. V. Pimm, S. C. Seymour, Camden, N. J.

Crescent Chemical Corp., Elizabeth, N. J. Capital, $20,000. To make and sell dyes, etc. Incorporators are F. Curtin, H. O. Coughlin, A. W. Button, all of Elizabeth, N. J.

Crew-Levick, Jersey City, N. J.; to deal in petroleum products. Capital, $3,500,000. Incorporators, J. D. Baker, J. P. Murray, F. F. S. Saurman, all of Philadelphia.

Burt C. Crittsinger, Inc., Niagara Falls, N. Y. Nominal capital, $5,000. To manufacture paper, wood pulp, etc. Incorporators are B. C. and M. Crittsinger and H. A. Constantine, Niagara Falls.

Davidson Pipe & Iron Corp., Brooklyn, N. Y. Capital, $10,000. Incorporators, Ellis Davidson, Chas. Levine, Philip Levine.

F. A. Dillingham, Inc., New York City. Active capital, $30,000. To manufacture chemicals, etc. Incorporators are F. A. Dillingham, A. B. Champlin and R. P. Ballard, 17 West Forty-second Street, New York.

Dicks, David & Heller Co.; to make dyes and dyestuffs. Capital, $40,000. Incorporators, W. B. Walsh and R. H. Miller, Brooklyn; H. Rothkowitz and M. E. Schaefer, New York. Incorporated in Delaware.

The Goodrich-Lockhart Co., Orange, N. J. Capital, $250,000. To manufacture chemicals, etc. Incorporators are M. P. Coffin, W. J. Maloney and E. J. McWhinney, Wilmington, Del.

Helvetia Commercial Co., Inc., New York. Capital, $50,000. Incorporators are W. Saenger, Norman M. Behr, Elizabeth L. Clancy.

Jules Hirschfeldt & Co., Inc., New York City. Capital, $25,000. To manufacture chemicals, dyestuffs, etc. Incorporators are C. M. Allen, A. M. Nascher and C. Hirschfeldt, 644 Riverside Drive.

Jefferson Rolling Mill Co., Birmingham, Ala. Capital, $150,000. To manufacture mold, refine and prepare for market iron, steel, clay and metals, etc.

The Karosenc Paper Box Co., Newark, N. J. Capital, $25,000. To manufacture paper boxes and kindred products. Incorporators are Harry Karosenc and J. and B. Fishtrom, Newark.

Kutsche Machine & Foundry Co., Pittsburgh. Capital, $220,000.

Lewes Oil & Chemical Co., Wilmington, Del. Capital, $500,000. Robert Pennington, S. H. Baynard, L. A. Brownhill of Wilmington.

The Marquette Oil Co., New York City. Capital, $250,000. To develop oil properties and gas lands. Incorporators are S. B. Howard, John A. Moore and A. W. Britton, 65 Cedar Street, New York.

The New Process Rubber Co., West New York, N. J. Capital, $100,000. To manufacture automobile tires by special process. Incorporators are Reinhard Brueckner, West New York, and T. Schelberger and John Berger, both of Union Hill.

The New York Tool Manufacturing Co., Alpine, N. J. Capital, $25,000. To manufacture tools, etc. Incorporators are P. Turpeach, Brooklyn, N. Y.; A. F. Andrews, New York City, and S. Yankus, Alpine, N. J.

Ocoee Copper Co., Knoxville, Tenn. Capital, $100,000. To manufacture brass.

The Perfenol Co., Elizabeth, N. J. Capital, $50,000. To manufacture synthetic products of various kinds. Incorporators are K. C. FitzSimmons, R. T. Green and H. F. Ratigan, all of Paterson.

The Pittsburg-Oregon Mining & Milling Co., Grants Pass, Ore., has filed articles of incorporation, with capital stock of $2,000,000. A general mining and ore marketing business will be carried on.

The Seton Chemical Co., West Hoboken, N. J. Capital, $50,000. To manufacture chemicals. Incorporators are A. Murray, Arlington; Edward Murray and E. Saling, Newark, N. J.

The Straight Line Manufacturing Co., New York City. Capital, $20,000. To manufacture chemicals and kindred products. Incorporators are R. A. Van Vechten, G. H. Bensen and N. H. Phillips, 206 Broadway, New York.

The Tejure Products Co., Inc., New York City. Capital, $10,000. To manufacture chemicals and allied products. Incorporators are B. Jurist and D. and A. B. Tietjen, 513 East 118th Street, New York.

Tri-City Steel Co., Dover, Del. Capital, $1,000,000. To make iron, steel, etc. Incorporators are F. D. Buck, J. D. Brook, K. E. Longfield, Wilmington, Del.

United Ohio & Chemical Corp., Delaware. Capital, $2,000,000. To deal in and with oils, greases, tars, chemicals, etc. Incorporators are F. A. Armstrong, C. M. Egner, W. S. Randall, Wilmington, Del.

Construction and Operation

California

LOS ANGELES.—The Stauffer Chemical Company of San Francisco is to establish a big manufacturing plant here, preliminary building contracts already having been let to Leonardt & Peck, a local firm. It is said that the construction costs of the group of buildings to be erected will range from $80 000 to $100,000. The initial contract is for the foundation of the main building, a structure covering a ground area of 116 by 240 ft., to be one story in height and of concrete, lined with fire brick and with fire brick floors. All of the buildings are to be similarly constructed. Plans are being drawn in San Francisco.

RICHMOND.—A contract has been let to an Oakland firm for erection of the buildings of the American Carbon Company's plant in this city. Surveys of the site have been finished and work is ready to start. The plant will be one of the biggest of the kind in the country.

STOCKTON.—A million dollar paper mill for the manufacture of that special quality of paper used in the making of boxes and cartons is planned for this city. The factory has purchased 37 acres of land in the Boggs tract just west of the McDougal site. The machinery has been ordered, and actual construction will commence very shortly. The name of the company has not yet been made public.

Idaho

COEUR D'ALENE.—The Carbonate Hill and Idaho Giant Mining properties have been consolidated by Wilbur Greenough, and both properties are to be extensively developed.

KELLOGG.—The smelter of the Bunker Hill & Sullivan Mining & Concentrating Company has been assessed at $426,000 by the Idaho Board of Equalization.

Louisiana

NEW ORLEANS.—B. W. Seidel, president of the Dixie Steel Corporation, recently announced the purchase of a factory site, measuring about 500 by 963 feet on the New Basin Canal paralleling the tracks of the New Orleans Terminal Railroad and the Public Belt. The location will enable the corporation to transport raw material from the Alabama fields to its mill through the New Basin Canal.

President Seidel stated that building operations will be started as soon as the details have been worked out by the company's architect, Sam Stone, Jr.

Maryland

BALTIMORE. — The Baltimore Tube Company is at present turning out 1,000,000 lb. of copper and brass tubing per month. Work on the rolling mill is being pushed, and it is expected that it will be ready for operation around the first of the year. This plant will make copper and brass plates exclusively, and the company already is assured of a ready market for the product.

This mill complete will cost approximately $700,000 and will be paid for out of earnings. The new mill will be equipped to turn out 1,000,000 lb. of plates and rods a month or a tonnage equal to that of the tube plant.

Minnesota

MINNEAPOLIS.—Work on a new plant that will cover 40 acres and manufacture creosote oils and chemicals was begun recently in St. Louis Park by the Republic Creosoting Company, which now maintains a plant in Twenty-fourth and Marshall avenues.

The new plant will be constructed by 200 men on the former site of the beet sugar factory in St. Louis Park and will be in operation early in December, according to A. E. Larkin, the company's Minneapolis manager. The present Minneapolis plant will be consolidated with the new one.

The new plant will manufacture creosote oils, carbolic acid, napthaline and other chemicals from tar, which is a byproduct of coke ovens. The tar will come from coke ovens in St. Paul and many towns in Minnesota and the Northwest that have coal gas plants.

Missouri

KANSAS CITY.—Plans for establishing a $5,000,000 powder plant in Kansas City have about been completed, according to C. C. Palmer, a local realty dealer. As the representative of an Eastern firm already engaged in the manufacture of powder and high explosive chemicals, Mr. Palmer said he has an option on 118 acres of land adjoining and just east of the properties of the Standard Oil Company at Sugar Creek, which is to be used as the site for the plant.

ST. LOUIS.—The proposed investment by the Monsanto Chemical Works of approximately $750,000 in the erection of a new plant in East St. Louis was announced yesterday by the East St. Louis Chamber of Commerce. The company's main plant is at 1800 South Second street, St. Louis.

Negotiations for the purchase of about 90 acres of ground in the vicinity of Mississippi avenue and the Terminal Railroad Association's belt line have been closed, according to Joseph N. Fining, manager of the chamber. It is on this site that the St. Louis firm plans to erect a large plant for the manufacture of chemicals.

Montana

ANACONDA.—The Richmond Mining Company, which has been shipping a portion of its ore to the Montana smelter of the Anaconda Copper Company at Anaconda, and the remainder to Tacoma, is now shipping all of it to the Tacoma Smelter. The company is also negotiating for a rate which will permit shipments to the smelter at Greenwood, B. C.

ANACONDA.—The Montana Tungsten & Silver Company has instructed Supt. J. E. Walker to rush work on the Hidden Lake cyanide plant, in order that it may be ready before winter. All the equipment for the concentrator is on the ground with the exception of the boiler.

ANACONDA.—On August 24, the Anaconda Copper Mining Company announced a general shutdown of its properties in the state, following a strike of smeltermen at the Washoe Smelter at Anaconda. All of the mines of the company have closed, together with the smelter at Anaconda. The smelter at Great Falls will be kept in operation until the ores in transsit are disposed of when it is expected it will be closed. Of the three thousand men employed at the Washoe plant, only 110 have reported for work. That the fires have been allowed to go completely out in the Anaconda plant, is an indication that the existing shutdown will be a prolonged one. The mines in the vicinity of Butte are without facilities for storing ore, and with smelters out of business, it is expected that most of the larger mines will be closed down.

New Hampshire

PORTSMOUTH.—The plant of the Agricultural Chemical Company, which owns the Eastern Oil & Rendering Company and the Eastern McElwain Company's plants will be enlarged. A large brick building is being planned.

New Jersey

HARRISON.—Plans were filed recently by the Crucible Steel Company of America for a new press and forge shop in Harrison, to cost $390,000. The building is to be of steel and brick and its dimensions are to be 222 feet wide, 427 feet long, and 132 feet high. It will contain an inner gallery 22 feet wide.

PATERSON.—The Society for Useful Manufactures sold several city lots on McBride avenue, adjoining the Hayes Manufacturing Company's plant, to the Fine Colors Company, for the sum of $6,370.

It is the purpose of the Fine Colors Company to erect a large mill on the property, the cost of which will be $20,000.

The Fine Colors Company manufacture newspaper colors, etc., and is at present occupying mill space in the old Gun Mill yards.

PATERSON.—The Commercial Chemical Company bought about twenty acres of the William T. Kyle estate, at East Forty-third street and the Boulevard, adjacent to the Susquehanna Railroad, Paterson, as a site for a large plant.

RUTHERFORD.—J. Sterling Drake and Edward S. Brown have sold to the Burns Manufacturing Company two acres of land at East Rutherford, N. J., to be used as a site for a chemical plant. The property fronts on Paterson Plank road and the rear rests on the Erie Railroad, main line, with private siding into the property.

AUBURN.—Having completed the main buildings of its new plant for making crucible and electric furnace steel, the Cayuga Steel Company, Ltd., of Auburn., N. Y., is to begin operations with two 28-pot crucible melting furnaces and two electric furnaces, a hammer plant and rolling mill.

BINGHAMTON.—The Hire's Condensing Company, an adjunct of the firm which manufactures the famous Hire's root beer, has purchased a 13-acre tract of land north of Hillcrest in the village of Port Dickinson, upon which tract it is to erect a plant at an estimated cost of $500,000, for the manufacture of metal condensing utensils.

BUFFALO.—Contracts were let recently for the erection of a new chemical plant on South Park and Colgate avenues, near the new Commercial Electrolytic corporation plant. It will be of reinforced concrete, and the contractors have agreed to have certain of the buildings ready for manufacturing within sixty days. This new plant will be owned and operated by the Great American Chemical Products Company, a $10,000,000 corporation, with headquarters at New York. The Buffalo plant will produce pharmaceutical chemicals.

Ohio

TOLEDO.—A fertilizer plant to employ 200 people is to be erected in Toledo by the Royster Guano Company, which operates eleven plants in the United States.

A 7-acre site on the Michigan Central tracks in West Toledo was purchased by the company.

Work on the plant will start immediately. The Toledo plant will be the northern distributing center for the company.

Oklahoma

ARDMORE.—A $1,000,000 steel plant is proposed by Missouri capitalists, who have asked for donation of a site here.

Oregon

ASTORIA.—Astoria Pulp & Paper Company will start operation of their new $100,000 plant which is practically completed. Waste paper will be used and made into pasteboard. It is stated the entire output has been contracted for.

OREGON CITY.—The Terrell Silicia Mines near this city are to be developed and extensive improvements made to them. Company has contracted with a San Francisco Products firm to supply 100 tons of silicia monthly for the next year. Product has previously been used almost entirely by Clackamas County as a filler for paving.

PORTLAND.—The American Mining & Smelting Company has brought suit in the Federal Court in Portland, to enjoin the Bunker Hill & Sullivan Mining and Concentrating Company, an Oregon corporation, from smelting its own ores in a new smelter recently built at Kellogg, Idaho. The complaint alleges that the plaintiff holds a 25-year contract for the exclusive smelting of ores mined by the defendant company, and that the contract lacks 12 years of expiration. The contracts call for all ore containing from 30 to 70 per cent. lead. The new smelter of the Bunker Hill Company can handle ore with a content of less than 30 per cent. and more than 70 per cent, according to Bunker Hill officials.

SALEM.—The Natural Fireproof Lumber Company, composed of Seattle business men, has been formed to develop a huge deposit of volcanic tuff or lava at Mount Angel, Ore., near Salem. The product is claimed to possess remarkable fireproof qualities, and will serve as cheap substitute for asbestos or other fireproofing. Company has acquired 4,000 acres of the land, and will immediately develop it. It is capitalized at $100,000 and is composed of F. T. Crowe, W. L. Rhodes, John W. Eddy, A. Warren Gould and A. D. Coulter.

Pennsylvania

TEMPLE.—The new plant of the Temple Malleable Iron Company at Temple, several miles north of Reading, will be larger than expected. The buildings will include a one-story malleable iron foundry, 136 by 288 feet; a hard-iron mill 32 x 170 feet; one-story pattern shop, 36 by 90 feet; core house, 50 by 70 feet; power plant for operation, 65 by 80 feet. The building will be brick, steel and reinforced concrete, and the new work and equipment will cost $500,000.

Texas

HOUSTON.—The Empire Gas & Fuel Company will soon begin the construction of an oil refinery on the site recently purchased adjacent to the Houston Ship Canal. The proposed plant will cost about $2,000,000, and the company will receive its oil supply from the Gulf Coast fields of Texas and the Healdton field of Oklahoma. Its subsidiary, the Producers' Refining Company, which owns a refinery at Gainesville, Tex., is connected with the Healdton field by means of a pipe line. The Empire Gas & Fuel Company will build a pipe line from its proposed refinery near here to Gainesville, a distance of more than 300 miles.

Washington

INDEX.—The Sunset Mines, Ltd., is planning construction of a concentrator and ore mill at its mining properties. Mill will have capacity of 100 tons of ore daily.

SEATTLE.—The Presto-Lite Company, owing to the rapid growth in shipbuilding industries and consequent demand for the company's products, has increased its output more than 100 per cent. During the month of July, according to W. E. Darden, Manager, Seattle shipbuilding plants and industries using rapid oxyacetylene welding and cutting instruments, used nearly 660,000 feet of acetylene gas. Company uses more than three carloads of carbide each month.

SEATTLE.—The Puget Sound Pulp & Power Company has filed articles of incorporation, with capital stock of $16,000,000, and it is reported plans the construction of a large power plant and paper mill in the vicinity of Seattle.

SEATTLE.—While the steam vessels of the port commission are not in any immediate danger of being laid up owing to the fuel oil shortage, as the commission recently entered into a contract with the General Petroleum Company to supply this commodity for the ensuing year, an experiment in the use of powdered coal will probably be made in the near future.

George Nicholson, chief engineer of the port, at yesterday's meeting submitted a proposal to experiment with powdered coal as a fuel, and he was authorized to conduct such experiments on the ferry Leschi as soon as he deemed it convenient.

SEATTLE.—Forced to the expenditure of between $400,000 and $500,000 by reason of the approaching famine in fuel oil, the Puget Sound Traction, Light & Power Company decided to-day upon radical changes in its steam heating plant at Western Avenue and Union Street and in its steam electric power plant at Georgetown.

"At Georgetown at an expense of between $200,000 and $250,000, we will put in chain grates, or automatic stokers, in which to burn ordinary coal, instead of the oil which we have been using there," according to Vice-President W. H. McGrath.

"On Western Avenue we shall spend an equal sum in the enlargement and conversion of our plant, beginning the work just as soon as we can get the necessary materials. It should all be completed by next spring. The present building will be extended along its present lines to hold the powdering apparatus for our new fuel, for boiler and for equipment.

"Most of the money, however, will be spent inside of the present building. We have an oil contract that runs for another year, but we will not be able to get enough oil to carry on our increasing business.

"Therefore we plan to install an entirely new system that will involve the burning of powdered coal."

SEATTLE.—Confirming many rumors that a huge steel plant would be built on Puget Sound, Bart B. Thane, Alaska mining man and associate of D. C. Jackling, announced recently that the plant, requiring a capital of $25,000,000 would be built.

"Present labor conditions, high price of materials and difficulties of transportation are the factors holding back construction," he said. "When these matters are cleared away work will be started." Considerable San Francisco capital is interested in the plant.

VALLEY.—The Valley Magnesite Company, here, has announced that it will expend more than $100,000 in construction and development of a modern calcine plant. Irving Whitehouse, director.

British Columbia

GREENWOOD.—The Greenwood Smelter of the Canada Copper Corporation has resumed operations with one furnace, and will blow in a second furnace as soon as sufficient coke begins to come in. Company is smelting ore from the Mother Lode Mine and Lone Star Mine.

TRAIL.—The second of the four copper furnaces at the Trail smelter of the Consolidated Mining & Smelting Company at Trail, B. C., has been blowing in, owing to improvement in the supply of coke that is being received from Crow's Nest. First furnace was placed in operation August 1st, after the battery had been cold for many weeks, due to strike of coal miners. Company hopes to receive sufficient coke in the near future to permit of utilization of entire group of copper furnaces. An immediate result of the two copper gold furnaces in blast will be proportionate increase of shipment of copper-gold ores from Rossland. Rossland shipments this year have been curtailed because of coke troubles. The new concentrator at Trail smelter is reported to be working satisfactorily in the experimental dressing of Sullivan ores by the oil flotation process.

Alaska

JUNEAU.—According to statement of B. L. Thane, Manager of the Alaskan-Gastineau Development Company, $25,000,000 will be expended in wood and pulp mills in that vicinity, as soon as certain contracts can be sent from the Government regulating amount of raw materials. He asserts that such a plant could profitably be installed, and compete with Canadian mills and pulp plants on an equal basis. Engineers have been investigating the project for more than two years.